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Manual OF Clinical Pathology

BY

RICHARD WEISS, M.A., Ph.D., F.C.S.

In Collaboration with

GEORGE HERSCHELL, M.D., London.

ANDREW CHARLES, F.R.C.S., Dublin.

PRICE 2/- NET.

LONDON

J. & A. CHURCHILL

7 GREAT MARLBOROUGH STREET

1910



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MANUAL OF CLINICAL PATHOLOGY

FOR THE
GENERAL MEDICAL PRACTITIONER

COMPRISING THE EXAMINATION OF
URINE, STOMACH CONTENTS, FÆCES, BLOOD,
AND THE
SERUM DIAGNOSIS
OF
SYPHILIS, TUBERCULOSIS, TYPHOID FEVER, &c.

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Preface

THE first edition of this work appeared in 1908 under the title of "Newer Methods for the Qualitative and Quantitative Analysis of Urine and Gastric Juice," and was an attempt to provide the practitioner of medicine with simple means by which the necessary examinations could accurately, rapidly, and cheaply be performed in the consulting room.

The very favourable reception which the little treatise was afforded by the Profession showed us that it appeared to meet a distinct want, and has encouraged us to extend the scope of the work, in the hope of further increasing its sphere of usefulness.

The present edition, re-written and enlarged by the inclusion, we believe, of most of the important clinical tests which can be carried out in daily practice without laboratory facilities, is offered as practically a new work, under the title of "Manual of Clinical Pathology."

The author has been fortunate enough to secure the co-operation of George Herschell, M.D. (Lond.) who is responsible for the sections dealing with the examination of the gastric juice and of the fæces; and of Andrew Charles, F.R.C.S.I., who has revised the chapter upon the analysis of the urine.

He takes this opportunity of thanking those members of the Medical Profession who have been kind enough to assist him with their suggestions for modifications and improvements.

R. WEISS.

London, 1910.

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On the use of Laboratory Methods in daily practice.

One of the most important privileges enjoyed by the medical man of the present day is the possibility of supplementing the information obtained from the anamnesis and the physical examination of the patient by definite data derived from laboratory methods.

Whilst our forefathers had to make their diagnoses by a laborious study of symptoms, and the comparatively meagre information which they could obtain from palpation, percussion, and auscultation, modern science places at the disposal of those who are willing to avail themselves of its assistance, methods of precision of the greatest utility.

And yet we are met with the anomaly that whilst on the one hand the physicians attached to hospitals, whose unrivalled experience one would imagine would render such assistance less necessary, eagerly avail themselves in their daily routine of the work of the clinical laboratories, on the other the general practitioner, with less opportunities of acquiring knowledge, is often content with a perfunctory examination of the urine for sugar and albumin.

It is true that an increasing number of medical men make use of the clinical laboratories now to be found in our larger cities, but these are available only to the comparatively few who live near at hand, and whose patients are able and willing to pay the laboratory fees. For the bulk of practitioners any laboratory work must be done by themselves or their assistants, and as part of their daily routine. Fortunately the great improvements which have recently been made in the methods employed in the direction of simplification render this quite possible, and the medical man without any special laboratory training by simply following plain and straightforward directions can make not merely a qualitative, but an actual quantitative analysis of urine or stomach contents with quite sufficient accuracy for clinical purposes.

There is no need to dilate upon the advantages of such examinations as they are familiar to all medical men, although hitherto looked upon as unobtainable. We need only mention Cammidge's reaction in the urine pointing to degenerative changes of an inflammatory nature in the pancreas, the presence of indican denoting putrefactive changes in the upper part of the intestine, and minute quantities of bile pigment suggesting cholangitis. Little

attention has been paid so far to the paramount importance of the urinary acidity, though it is known that a large proportion of diseased conditions both organic and functional, are always associated with disturbances of metabolic processes, so that the determination of the urinary acidity will often afford a clear insight into the actual condition present in the body especially in relation to the metabolic activity of the body.

Again, how seldom is an attempt made in cases of indigestion to ascertain the true cause of the symptom? Although it is generally admitted that the examination of the contents of the stomach, both when fasting and after a test meal, is absolutely necessary for the diagnosis and efficient treatment of many gastric affections, it is often, we may say usually, omitted by the practitioner on account of difficulties mostly imaginary. In the first place, there is a deeply-rooted belief in the minds of medical men that the patient will not submit to intra-gastric methods. In the second place, an exaggerated idea has been formed of the difficulty of the subsequent analysis. As a matter of fact it is extremely rare to meet with a patient who will not allow a tube to be passed when convinced of the necessity, and as we only require to recognise gross departures from the normal, the simple titration methods provide us with a means of analysis quite accurate enough for clinical work. In fact, we can usually learn nearly all which we require from a simple macroscopic and microscopic inspection of the contents of the stomach after a test meal. Having thus ascertained exactly what happens to the food after it has passed into the stomach, we can form an opinion as to the nature of the disorder of digestion from which the patient suffers with some approach to scientific accuracy.

By the examination of the stools we are able to measure the exact time taken by the food to pass through the alimentary canal, we can diagnose a catarrhal condition and locate it respectively in the small or large intestine, and we can demonstrate an increase or diminution in the pancreatic secretion. By the test for occult blood we can ascertain whether there is any bleeding spot in the gastrointestinal tract, and confirm or otherwise a suspicion of malignant disease.

The latest modification of the Wassermann test places it in the power of any practitioner to ascertain whether specific syphilitic infection is present in any given case, a knowledge which will throw light upon many obscure affections, and will be of great value for prognosis and treatment. An exact estimation of hæmoglobin present in blood can be performed rapidly and with ease by the method described, and to those practising in the tropics the diagnosis of Typhoid and Malta fever is rendered possible with a degree of accuracy hitherto not within their reach. On the value of v. Pirquet and Calmette's reactions for tuberculosis it is needless to dilate, and the methods now available are so

simple and safe and take so little time that they can readily be adopted in the rush of practice.

Taking everything into consideration, the adoption as far as he is able of laboratory methods in his daily work is bound to be of immense advantage to any medical man. Not only will he have increased confidence in his diagnoses, based as they will be upon definite observed data rather than upon simple opinion, but the mere fact of the scientific work performed will tend to make him more accurate in his observations, more careful in his deductions, and in every respect a more accomplished clinician.

Analysis of Urine.

I.—CONSTITUENTS OF NORMAL URINE.

	Men.	Women.
Total in 24 hours	1400-1600 c.c.	1200-1400 c.c.
Total of Urea	35 grms.	30 grms.
Percentage of Urea	2·35 per cent.	2·3 per cent.
Total of Uric Acid (Hopkins)...	1 gm.	0·857 gm.
Percentage of Uric Acid ...	0·066 per cent.	0·066 per cent.
Ratio of Uric Acid to Urea...	1 to 35.	
Total of Chlorine (Parkes) ...	7·5 grms.	6·75 grms.
Percentage of Chlorine ...	0·5 per cent.	0·52 per cent.
Expressed as Na Cl	0·825 per cent.	0·858 per cent.
Percentage of Phosphates ...	0·21 per cent.	0·22 per cent.
Total Phosphates	3·16 grms.	2·8 grms.
Acidity	From 30 to 40 per cent.	
Total Sulphates	2·01 grms.	
Total Solids	50 grms. (1½ oz. of Solids).	

I. Urea.

Normal amount secreted in the 24 hours, 33 grms. or 500 grns., that is, about 10 grns. to the ounce of urine. Urea is soluble in urine and never precipitated.

Clinical Significance.

Increased in: Acute febrile disorders, diabetes mellitus, plethoric individuals.

Diminished in: All forms of Bright's disease, acute yellow atrophy of the liver; sudden diminution in diabetes before the onset of coma (Ralfe).

2. Uric Acid.

The normal amount secreted daily, .4 to .7 grms., or 7 to 10 grns.

TEST. Murexide.—Place a few crystals of uric acid with a drop or two of nitric acid in a porcelain capsule. Heat to dryness. To the residue a drop of ammonia gives a purple red.

Clinical Significance.

Increased in: Dyspepsia, gout, jaundice, ague, fevers, leucocythemia.

Diminished in: Anæmia, chronic nephritis, diabetes mellitus.

Salts of uric acid occurring in the urine:—

- (1) Amorphous urates; (2) Ammonium urate.

Clinical Significance.

Amorphous Urates: Profuse sweating, violent exercise, febrile conditions, derangements of the digestive system.

3. Phosphates.

Normal amount secreted in 24 hours, 2 to 3 grms. In the form of earthy and alkaline phosphates. Alkaline phosphates do not deposit.

- TEST. (1) Ammonia gives white ppt.
(2) Earthy phosphates in solution are pptd. by heat; the ppt. is dissolved on addition of acetic acid.

Clinical Significance.

Increased in: Neurasthenia, rickets, gastric disease (where there is great loss of hydrochloric acid), acute cerebral inflammation, osteomalacia, vegetable diet, sexual excesses.

Diminished in: Gout, kidney disease (acute and chronic Bright's disease).

4. Sulphates.

Normal amount secreted in the 24 hours, 2 grms.

Occur in the urine in 3 forms:—

- (1) Unoxidised sulphates.
(2) Neutral sulphates.
(3) Ethereal sulphates.

Ethereal sulphates are the most important clinically.

TEST for Ethereal Sulphates or INDICAN.

- (1) To albumin free urine add an equal quantity of hydrochloric acid, and a few drops of nitric acid; boil, cool, and add a few drops of chloroform. The chloroform drops become a violet tint.

- (2) To albumin free urine add an equal quantity of hydrochloric acid and a few drops of chloroform; add drop by drop hydrogen peroxide. The chloroform becomes a bluish reddish violet colour. Do not shake the tube.
- (3) To a mixture of 5 c.c. each of urine and concentrated hydrochloric acid, add 3 or 4 drops of a $\frac{1}{2}\%$ sol. of potassium permanganate. Shake. Add 2 c.c. of chloroform, and a few more drops of the permanganate sol. Shake. If Indican be present it is liberated as indigo blue and dissolved in the chloroform, which it colours blue.
- (4) See page 24 and 25, Quantitative Analysis.

TEST for ORDINARY SULPHATES.

Acidulate with acetic acid; add barium chloride; equals white ppt.

Clinical Significance of Ethereal Sulphates (Indican).

Increased in: Constipation, chronic catarrh of upper part of intestine, intestinal obstruction, any condition causing defective absorption in the intestines.

5. Oxalates.

Occur in urine normally to a very small extent, about .017 grms. daily.

- TEST. (1) Microscope. Envelope-shaped crystals.
 (2) Oxalates are insoluble in acetic acid, but soluble in hydrochloric.

Clinical Significance.

Increased in: Mental depression, dyspepsia, spermatorrhoea, epilepsy, certain articles of diet, as rhubarb, asparagus, tomatoes, cocoa, etc., and in chronic pancreatitis.

6. Chlorides.

Normal amount secreted in 24 hours, 10 to 15 grms., especially in the form of sodium chloride.

- TEST. To albumin free urine add a few drops of nitric acid to prevent the ppt. of phosphates, then add drop by drop a sol. of nitrate of silver (1 in 8). If normal or increased, the ppt. forms a compact ball, which sinks to the bottom of the tube. If the chlorides are decreased, the ppt. is more or less flocculent.

Clinical Significance.

Decreased in: Pneumonia, pyæmia, puerperal fever, acute rheumatism, gastric disease (especially pyloric cancer), chronic febrile disease, Bright's disease.

Increased in: Cirrhosis, diabetes mellitus, ague.

II.—PHYSICAL CHARACTER OF URINE.

Before examining the urine, either QUANTITATIVE or QUALITATIVE, determine:—

- (1) Colour.
- (2) Quantity.
- (3) Reaction.
- (4) Transparency.
- (5) Odour.
- (6) Specific Gravity.
- (7) Colour of deposit if it has been allowed to cool.

1. Colour (Normal, Yellow to Amber).

Pathological Colours—Undue Pallor—Chronic interstitial nephritis, diabetes insipidus, diabetes mellitus, hysteria, chlorosis, excessive drinking, epilepsy, convalescence from acute diseases.

Smoky, Bright Red, Dark Red, Red: Blood.

Bright Yellow or Orange: Aniline dyes in sweets, Santonine.

Yellowish Green: Bile.

Reddish Brown: Rhubarb Senna.

Black: Melanotic Sarcoma, Alkapton.

Olive Green: Large quantity of Indican Phenol and its derivatives.

Yellowish or Milky: Pus, Fat.

2. Quantity.

Normal quantity, 1,500 c.c. or 50 ounces.

Decrease of Quantity: Fevers, acute nephritis, heart failure, shock.

Increase of Quantity: Granular kidney, diabetes mellitus, diabetes insipidus, epilepsy, amyloid kidney, nervous excitement, convalescence from acute fevers.

3. Reaction.

Normal urine is acid in reaction.

Acid.—Turns blue litmus paper red.

Alkaline.—Turns red litmus paper blue. If the alkalinity is due to ammonia, the blue colour fades on drying, turning red again.

Amphoteric Reaction: Means urine which changes blue litmus paper red, and also turns red litmus paper blue, due to the presence of both acid and basic phosphates.

Clinical Significance.

Undue Acidity: Acute fevers, uric acid diathesis.

Diminished Acidity: Alkaline drugs, vegetable diet, abnormal conditions of gastric digestion.

Alkalinity: Cystitis.

4. Odour.

Characteristic aromatic odour, when allowed to stand becomes ammoniacal.

5. Transparency.

Normal urine is clear when passed.

Change in the transparency may be due to phosphates, pus, blood, chyle, bile, mucous, bacteria.

6. Deposit.

Urine when first passed is clear. A slight cloud of mucus forms on cooling. If the urine is concentrated, a pink deposit of urates form. If after a meal consisting principally of vegetables the urine may be cloudy, due to the presence of earthy phosphates.

Deposits occurring in urine may be Pathological or Physiological:—

White: Due to phosphates, oxalates, pus, mucus, pale urates.

Pink: Urates.

Brown: Phosphates with blood.

Red: Uric acid.

Crimson: Blood.

7. Specific Gravity. (Normal, 1020).

The sp. gr. is determined by filling a glass cylinder with urine, in which you immerse the Gravidimeter. The sp. gr. is indicated at the division on the scale where the surface of the urine reaches.

Note.—If the amount of urine be insufficient to allow of the sp. gr. being taken, the urine may be diluted with a known quantity of water, then take the sp. gr. of this mixture and multiply last two figures of the sp. gr. by the amount of dilution. For example: If the sp. gr. of the mixture is 1005 and three parts of water were added, *i.e.*, 1 in 4, the sp. gr. of urine would be 1020.

Precautions in using the Gravidimeter: The instrument must float freely. The surface of the urine should be free from froth. The instrument should be dry and clean.

Increase of Specific Gravity: Heart failure, 1030-1035; acute fevers, 1030-1035; diabetes mellitus, 1035-1045.

Decrease of Specific Gravity: Diabetes insipidus, 1002-1004; hysteria, 1004; post epileptic, granular kidney, 1008-1012.

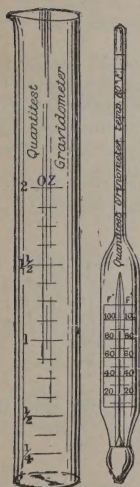


Fig. 1.

III.—ABNORMAL CONSTITUENTS OF URINE.

1. QUALITATIVE EXAMINATION.

1. Albumin.

(1) Acidify urine if not already acid with a few drops of dilute acetic acid and boil; a ppt. forms which does not dissolve on the addition of acetic acid.

(2) To test-tube containing about half an inch of nitric acid add an equal quantity of urine so as to form a layer on the top: equals a white layer of coagulated proteid at the junction of the two fluids.

Fallacies: Urea and Copaiba.

(3) Add picric acid solution, drop by drop, to acid urine in a test-tube: equals a yellowish white ppt.

Fallacies: Mucin, peptone and quinine.

(4) To a test-tube containing about half an inch of Spiegler's solution (mercur. chloride 8, tartar. acid 4, glycerin. 20 c.cm., water 200 c.cm.) add an equal quantity of urine so as to form two layers: equals a white ppt. at the junction of the two fluids (very delicate test).

Clinical Significance.

Albumin is not found in urine under normal conditions, but it may occur in individuals without any disease of the genito-urinary tract. This form of albuminuria is called physiological albuminuria. Pathological albuminuria may be due to (a) To toxic, infective, and circulatory conditions; (b) Diseases of the genito-urinary tract.

2. Sugar (Glucose).

(1) Take equal parts of Fehling's solution 1 and 2, say half an inch of each in a test-tube, boil, and if it becomes turbid or loses its colour it is unfit for use. If it retains its colour, add an equal quantity of urine free from albumin, that is, urine boiled and filtered; heat again: equals a brick-red ppt. of cuprous oxide.

Note.—Boil the solution before using; re-examine the tube on cooling; avoid much boiling. Urine must be free from albumen.

Fallacies: Drugs (camphor, chloral, glycerine), uric acid, creatinine, xanthine, lactose.

(2) Take an equal quantity of liquor potassæ and safranine solution (1-1000) and albumin free urine. The mixture becomes deep red and opaque. Heat, and on cooling, if more than one-tenth per cent. of glucose is present, the opaque red colour disappears and a yellow colour takes its place.

(3). Add some washed yeast to urine in a ureameter and place in a warm place for 24 hours. If glucose is present CO_2 will collect in the closed end of the tube.

Note.—This method distinguishes lactose from glucose, as lactose does not ferment. Lactose gives the same reactions in urine as glucose.

(4) To albumin-free urine add an equal quantity of liquor potassæ and as much bismuth sub-nitrate as will lie on the point of a penknife; boil: equals a black ppt. of metallic bismuth.

(5) Boil 5 c.c. of Haines solution (copper sulphate 4 grm., water 30 c.c., glycerine 30 c.c., and KOH, 5% sol., 240 c.c.). Add 6 or 8 drops of suspected urine. Sugar causes a yellowish red ppt. If 10 drops produces no reaction, the urine is free from sugar.

(6) To 5 c.c. of urine add a crystal of phenylhydrazine hydrochloride (size of a pea) and twice this amount of sodium acetate. Boil the mixture on a water-bath for 15 or 20 minutes and examine microscopically for the characteristic yellow, needle-like crystals of phenylglucosazone. This test detects the least trace of glucose.

Clinical Significance.

Diabetes mellitus, where it may be present up to 10%, meningitis, cerebral hæmorrhage, cerebral tumour, injuries to the head, drugs (morphia, chloral, chloroform).

Functional glycosuria occurs at intervals as the result of a large ingestion of carbo-hydrate diet.

3. Diacetic Acid or Aceto Acetic Acid.

To an inch of urine in a test-tube add liq. ferri perchlor drop by drop, filtering off the ferric phosphate which is thrown down. If diacetic acid is present the liquor becomes a burgundy red colour, disappearing on heating.

Fallacies: Carbolic acid, salol, salicin, salicylates, anti-pyrin, etc., give the same reaction, but heat will not discharge the red colour.

Clinical Significance.

Diabetes often precedes the onset of coma, fevers.

4. β -Oxybutyric Acid.

If diacetic acid is present in the urine β -oxybutyric acid is probably also present.

The test for β -oxybutyric acid as carried out by Kulz consists in removing all the albumin and sugar in the urine, also decolourising by-ppt. with lead acetate and ammonia. Then examine the urine with the polariscope. β -oxybutyric acid is Lævo-rotary.

5. Acetone.

(1) To urine in a test-tube add 10 or 15 drops of liq. potassæ and a small quantity of an aqueous solution of iodine in potassium iodide: equals iodoform ppt., which can be recognised by the smell, or by the microscope, showing hexagonal crystals.

(2) Pour about 3 c.c. of urine into a test-tube and add a few drops of a fresh solution of sodium nitro-prusside (a crystal in 5 c.c. of water). Add concentrated ammonia water so as to form two layers. If acetone be present even in minute quantities a well-marked characteristic magenta colour appears at the junction of the two fluids and spreads upwards (Jackson Taylor).

(3) Add about 1 grm. of solid caustic potash to 10 c.c. of urine. Before the caustic potash has dissolved add 10 drops of a solution of salicylic acid 1, absolute alcohol 10. Heat to about 70 degrees C. In the presence of acetone a scarlet ring is formed. A very delicate test that no other constituent of the urine will give (Frommer).

Clinical Significance.

Diabetes mellitus (frequently indicates the approach of coma).

Auto-intoxications, chloroform narcosis, cancer, febrile conditions.

It also occurs in all normal urines to a small extent.

6. Bile Pigments.

(1) To a piece of filter paper soaked in bile (or urine containing bile), add a drop of nitric acid; equals a play of colours—green, violet, red, yellow.

(2) Add chloroform and shake: equals yellow colour.

(3) To a test-tube containing urine add an aqueous solution of methyl-violet, so as to form two layers, at the junction of the two fluids: a bright carmine red ring forms.

(4) To an inch of urine in a test-tube add by means of a pipette so as to form two layers diluted tincture of iodine in alcohol (sherry colour). If bile pigments be present, at the line of junction a green ring forms.

7. Bile Salts.

(1) To urine in a test-tube add a small quantity of solution of cane sugar; shake to a froth; then add drop by drop concentrated sulphuric acid: a purple colour appears in the froth.

(2) Sprinkle finely-divided commercial sulphur on the surface of the urine. If bile salts are present, the sulphur sinks. A very delicate test (Hale).

Clinical Significance.

Jaundice due to obstruction.

Acute yellow atrophy.

Pyæmia.

Mineral poisons, phosphorus, arsenic.

Puerperal fever, typhus and typhoid.

8. Urobilin.

(1) Place an inch of urine in a test-tube, add half an inch of ammonia, add zinc chloride solution, drop by drop, or a 10% sol. of zinc acetate in absolute alcohol. Filter. If urobilin be present, the filtrate will be fluorescent.

(2) 10 c.c. of urine are acidulated with acetic acid and then about $2\frac{1}{2}$ c.c. of a 10% liq. plumbi sub-acetatis is added. The mixture is filtered and the filtrate shaken with amyl-alcohol, which will then show a colour varying from yellow to deep orange, according to the quantity of the urobilin present. An addition of chlor-zinc-ammonia will produce florescence. (The latter is prepared by dissolving zinc chloride 1 grm. in alcoholic ammonia 100.)

Clinical Significance.

A very small quantity of urobilin is present in normal urine. The amount present is increased in diseases of the liver, tubercular peritonitis, pernicious anæmia, and 50% of the cases of chronic pancreatitis. Larger quantities point to there being some interference with the functions of the liver and probably some cholangitis. The reaction is well marked when due to the presence of floating gall stones on the common bile duct.

9. Pus (Pyuria).

(1) Liq. potassæ produces a ropy gelatinous condition.

(2) Hydrogen peroxide liberates oxygen.

(3) Tincture guaiacum plus hydrogen peroxide equals greenish colour disappearing on heating.

(4) Microscope shows pus corpuscles.

Note.—Pus might be mistaken for:—

- (1) Phosphates.
- (2) Urates.
- (3) Mucus.

Phosphates increase on heating and dissolve in acetic acid.

Urates dissolve on heating.

Mucus dissolves in KOH.

Clinical Significance.

Suppurative conditions of any part of the genito-urinary tract.

10. Melanuria.

- (1) Bromine water gives yellowish ppt. which turns black.
- (2) Liq. ferri perchlor gives grey colour, soluble in excess.

Clinical Significance.

Melanotic Tumours.

Malaria.

11. Blood.

- (1) Microscope, showing the red blood corpuscles (hæmaturia).
- (2) Add to urine in a test-tube an excess of liq. sodæ; boil: equals a brownish red deposit. (This deposit is composed of hæmatin and earthy phosphates.)

Fallacies: Senna, rhubarb, and santonine.

(3) **GUAIACUM TEST.**—Take an equal quantity of urine and hydrogen peroxide, and add a few drops of freshly prepared tincture of guaiacum: equals a blue colour.

Fallacies: Iodides, pus, and saliva.

(4) **Spectroscope.**—The most usual form of hæmoglobin to find in the urine is methæmoglobin, but oxyhæmoglobin may also be found. Oxyhæmoglobin: 2 dark bands will be seen in the yellow part of the spectrum. Methæmoglobin: 2 dark bands in the yellow portion of the spectrum and 1 dark band in the red.

(5) Mix 3 c.c. of urine and hydrogen peroxide with a small amount of powdered aloin and heat. If blood be present, the mixture will assume a bright purple colour. This colour may also be found with alkaline urines, but if due to blood the colour is not discharged on acidifying with acetic acid (Klimoff).

Clinical Significance.

Hæmaturia (Blood Corpuscles): Hæmorrhagic diathesis, hæmophilia, malaria, acute specific fevers. Genito-urinary inflammations, tumours and congestion of the genito-urinary organs.

Hæmoglobinuria (Blood Pigment): Paroxysmal—cold, exertion.

Sympathetic—Raynaud's disease.

Toxic—Carbolic acid, chlorate of potash.

12. Mucin.

(1) Acetic acid gives ppt. slightly soluble in excess, ppt. increasing on heating.

(2) Liq. potassæ dissolves mucin.

Note.—To distinguish mucin from albumin, filter, and this removes the mucin.

In HNO_3 test for albumin, mucin collects at the top of the urine, not at the junction of the two fluids.

Clinical Significance.

Catarrh of the bladder and urethra.

13. Diazo Bodies.

To an equal quantity of urine and sulphanilic acid solution (which contains sulphanilic acid with 5% solution of HCl.) add a few drops of $\frac{1}{2}\%$ solution of sodium nitrite solution and a few drops of liq. ammonia: equals dark red colour. Shake and froth becomes a rose red.

Clinical Significance.

Typhoid.

Acute miliary tuberculosis.

Also in measles, scarlet fever, erysipelas and malaria.

2. QUANTITATIVE ESTIMATIONS.

1. Albumin.

(a) By ESBACH'S Improved *Albuminometer* (Hayward).

Solution required:

ESBACH'S REAGENT: Picric acid, 10 grms.; citric acid, 20 grms.; boiling water, 800 c.c.; water up to 1 litre, and allowed to cool. Or by:

(b) JOHNSTON'S MODIFICATION: Picric acid, 5 grns.; boiling water, 1 ounce. (Allow to cool before using.)

Pour the urine into the tube up to the mark U, then the reagent up to the mark R. Close the tube with the cork, and invert so as to mix thoroughly without shaking. Allow the corked tube to stand upright for 24 hours, then read off on the scale the height of the coagulum. The figures indicate the grammes of albumin per litre of urine.

The percentage is obtained by dividing by 10, thus: if the coagulum stands at 3, the amount of albumin is 3 grammes per litre, or .3%. The percentage multiplied by 4.375 equals grains of albumin per fluid ounce.

Note. (1) The urine must be acid.

(2) If the sediment is above 4 on the scale, more accurate results are obtained by diluting the urine with 1 or 2 volumes of water, then multiplying the resulting figure by 2 or 3 as the case may be.

(c) By the "Quantitest" Albuminometer.

Fig. 2, which is the latest instrument devised for this important estimation. Its use permits of greater simplicity and accuracy (especially for small quantities of albumin) than either the Esbach Albuminometer or the Purdy tube. The test can be completed in a few minutes.

Fill the tube to the mark R with 5 c.c. of a reagent consisting of phospho-tungstic acid 1.5 gm., conc. HCl 5 gm. and abs. alcohol to 100 c.c. Having previously diluted the urine (1 in 10 is best), add the dilution drop by drop, shaking between each addition, until a faint white cloud appears. This constitutes the reaction, and the level of the fluid in the tube is carefully noted. This corresponds to the amount of diluted urine that contains one-tenth of a milligram (0.0001 gm.) of albumin. The percentage is easily determined. Example: .8 c.c. of diluted urine produces the reaction and is, therefore, the equivalent of .0001 gm. albumin. Then .08 c.c. *undiluted* urine equals .0001 gm.; 8 c.c. equals .01 gm., and 800 c.c. equals 1 gm. of albumin. The percentage is: 800 : 1 :: 100 : per cent., or 0.125 per cent. The amount of albumin excreted in 24 hours is found by multiplying the percentage by the amount of urine passed and dividing by 100.

The amount of added urine, if *undiluted*, which produces coagulum contains .0001 gm. albumin, or $\frac{1}{10}$ of the amount if diluted (1-10).

The following table will save some calculation:—

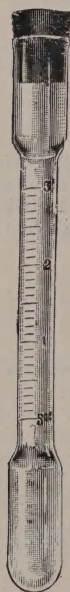


Fig. 2.

C.C. of Urine Reacting	Percentage ; or Grammes of Albumin per 100 c.c.				
	Dil. 1 in 30	1 in 20	1 in 10	1 in 5	1 in 3
3	'100	'066	'033	'015	'01
2'8	'105	'07	'035	'017	'010
2'6	'115	'075	'038	'019	'011
2'4	'125	'082	'041	'020	'012
2'2	'135	'09	'045	'022	'013
2	'150	'1	'05	'025	'015
1'8	'165	'11	'055	'027	'016
1'6	'187	'125	'062	'031	'018
1'4	'214	'142	'071	'035	'021
1'2	'25	'166	'083	'041	'025
1	'3	'2	'1	'05	'03
'8	'375	'25	'125	'062	'037
'6	'50	'33	'166	'083	'05
'4	'75	'50	'25	'125	'075
'2	1'5	1	'5	'25	'15
'1	3	2	1	'5	'3

2. Urea.

Fill the vertical tube of the "Quantitest" *Ureameter* with a solution of sodium hypobromite. When the entire tube is filled and the bulb about one-third full, turn the apparatus to the vertical position. Fill the side tube to 0 with a mixed sample of a 24-hour specimen of urine. Turn the tap and allow 1 c.c. to pass very slowly into the long tube. As the urine meets the hypobromite solution, the urea is decomposed and nitrogen is set free. The gas collects in the upper part of the tube, where in a few minutes, the froth and bubbles having subsided, its volume is measured. Each small division on the scale of the vertical tube indicates '001 gramme of urea in 1 c.c. of urine and each large division of the scale = '01 gm. per c.c. of urea. The percentage of urea is obtained by multiplying the result of the test by 100. (Normal percentage is about 1'5 to 2'5).

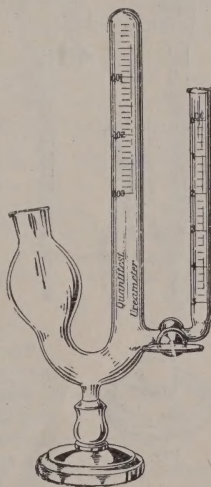


Fig. 3.

Note. (1) The albumin must be removed before making the test.

(2) If the percentage of urea present is high, the urine must be diluted, and the result multiplied by the amount of dilution.

- (3) Sodium hypobromite solution should be freshly prepared. Take 25 c.c. of a 40% sol. of sodium hydrate and add 2 c.c. of bromine (bromine is supplied in capsules; the capsule should be sharply dropped into the bottle containing the sodium hydrate with its fine end down, so that the impact may break the capsule and liberate the bromine). Shake gently; the solution is now ready for use.

3. Sugar.

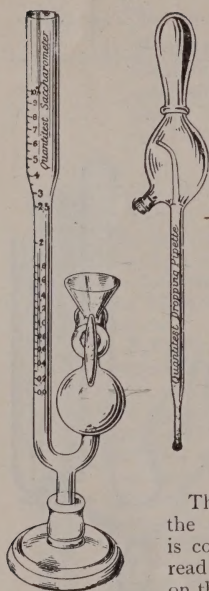


Fig. 4.

The "Quantitest" *Saccharometer* permits of rapid and correct determination of the amount of sugar without test solutions or measurement instruments.

The apparatus is used as follows :—

Open the stop-cock of Saccharometer and pour mercury to the mark 0, through the open end of the apparatus, pipette .5 c.c. of *acid* urine (using the special "Quantitest" pipette which sucks up exactly .5 c.c. into its capillary tube by means of the rubber teat) on the mercury in the bulb, and add 5 drops of yeast emulsion (1 gm. of fresh yeast to 5 c.c. of water). By inclining the apparatus the top of the mercury column is adjusted to 0. Carefully close the stop-cock and place the apparatus in a room at the ordinary temperature for about 4 to 6 hours.

The CO_2 evolved drives the mercury up the graduated tube, and when fermentation is complete the percentage of sugar may be read directly from the scale (the graduations on the scale are in 20ths per cent. up to 1.5 per cent. and halves per cent. from 1.5 per cent. to 10 per cent.).

To obtain the number of grains of sugar per ounce of urine the percentage must be multiplied by 4.375.

After using, the mercury may be poured out and the fluid portion blotted off with filter paper. The apparatus and pipette may be rinsed with water. The stop-cock should be slightly greased after drying.

4. Uric Acid.



Solutions required :—

- (1) Sol. Iodo-Iodide of Potassium : Iodine 5 grms. ; iodide pot. 1.25 grms. ; alcohol 7.5 c.c. ; glycerine 5 c.c. ; water ad 100 c.c.
- (2) Carbon Bi-sulphide.

The *Uricometer* consists of a long graduated tube. The scale on the tube denotes the values in parts per 1000.

To carry out the TEST :—

The *Uricometer* is filled with carbon bi-sulphide up to the lowest mark S, so that the lower plane of the double meniscus is on the mark S. Add iodo iodide solution up to the mark J, then urine until the mixture is the same colour as the urine to be tested. Shake, adding urine drop by drop, shaking after each addition until the carbon bi-sulphide attains a faintly pink (almost white) colour. Now read off percentage at the level of the fluid.

If the urine contains less uric acid than the apparatus can indicate add carbon bi-sulphide to the mark S, and iodine solution to the mark between S and J and water up to the mark J, divide the final result by 2.

Fig. 5. The time required to perform this test is about 5 minutes.

Note.—The urine must be acid. If there is a deposit of urates, the urine should be well shaken. If the urine contains a large amount of albumen, it must be coagulated by heating and the urine filtered.

5. Urinary Acidity.

Solutions required :

- (1) Phenolphthalein indicator $\frac{1}{2}$ 0% in 50 0% of alcohol.
- (2) Deci-normal solution of sodium hydrate.

Fill the "*Quantitest*" *Acidimeter* to the 10 c.c. mark with a thoroughly mixed 24-hour specimen of urine. Add 2 drops of phenolphthalein indicator and slowly add drop by drop deci-normal sodium hydrate solution. Invert the tube between each addition, and as soon as a permanent pink colour appears, the amount of acid in degrees is read at the level of the fluid on the tube. Each degree of acidity represents the amount of standard sodium hydrate required to neutralise 100 c.c. of urine.

The normal acidity is from 30 to 40 degrees.

Note.—If the specimen be alkaline follow the above procedure, but discharge the permanent pink colour with a deci-normal oxalic acid solution. The amount of acid in degrees is read at the level of the fluid in the tube.

The deci-normal NaOH solution must be made approximately and standardised by titrating against a standard oxalic acid solution.

6. Phosphates.

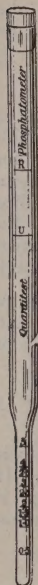


Fig. 6.

Solutions required :

Solution Magnesia : Magnesia chloride 5 grms. ; ammonia chloride 7 grms. ; ammonia water (10%) 35 c.c. ; dist. water 65 c.c.

Shake well before using. (The mixture will only keep for 14 days).

Pour urine into the *Phosphatometer* tube up to the mark U, then add reagent up to the mark R, shake well and allow to stand for 18 hours. Shake again and allow to stand for 6 hours. The height of the ppt. which is produced is noted, the figures on the tube indicating the amount of H_3PO_4 thus :—

Mark on Tube.	Grains per pint.	Grms. per litre.
.5	3 1-2	.4
.7	4 3-4	.5
.8	5 1-4	.55
1.0	7	.8
1.5	7 7-8	.9
2.0	8 3-4	1.0
2.5	11 3-8	1.37
3.0	13 1-8	1.5
3.5	14 7-8	1.7
4.0	17 1-2	2.0
4.5	21 7-8	2.5
5.0	24 1-2	2.8

Note.—If the quantity of urine be less than 800 c.c. in the 24 hours' sample; or if the specific gravity is between 1014 and 1025 it should be diluted with two parts of water and the result multiplied by degree of dilution.

If a small amount of phosphates is present, the ppt. settles quietly .7% phosphoric acid at once.

1% in about 1 hour.

1.5% in 3 hours.

2% in 4 hours.

2.5% in 10 hours.

7. Sulphates.

Solutions required:

- (1) Hydrochloric acid.
- (2) Solution barium chloride, 10% solution.

Place 25 c.cm. of filtered urine in the Sulphatometer, and add 2 c.cm. of hydrochloric acid and 5 c.cm. of a hot solution of barium chloride. The contents of the tube are shaken and the tube placed in hot water.

It may be necessary to tap the tube from time to time in order to get the ppt. to settle in the narrow end of the tube.

In 24 hours' time read off from the scale on the tube the amount at the level of the ppt.; this gives the number of grammes of sulphuric acid per litre in urine.

The marks between the figures on the scale correspond with one-fifth of a gramme.

As well as acid sulphates and ethereal sulphates, you have in the urine non-oxidized sulphates to the extent of .0044 to .0128 grms. per day. The pathological maximum is .0811 grms., which occur in diseases of the central nervous system: chronic tuberculosis, and in a lesser degree in carcinoma and anæmia.

The total sulphur compounds can be determined by evaporating 10 c.c. of urine with 1 gm. of KNO_3 in a porcelain dish heated until a white ash remains. This ash is dissolved in 25 c.c. of water, and estimated as above. The figure now obtained indicates the total sulphur compounds, the difference between the figure obtained in the first test and the second test representing the quantity of organic sulphur compounds present.

8. Ammonia.

Solutions required:

- (1) Deci-normal soda solution.
- (2) Phenolphthalein indicator.
- (3) 40% sol. neutral formaldehyd.

The relation between the urea index and the amount of ammonia is very important, as it very often shows the existence of disturbed metabolic conditions of obscure origin. The average normal percentage of urea varies from 1.5 to 2.5, the total excreted in 24 hours being from 25 to 30 grammes or about 80% of the total urinary nitrogen. The normal ammonia contents of the urine is about .7 grammes in 24 hours or only 3% of the total nitrogen. To estimate the amount of ammonia collect 24 hours' urine and mix thoroughly. Fill the "Quantitest" ammoniameter with the urine to be examined up to the mark U (10 c.c.). Add a few drops of the phenolphthalein indicator, neutralise with deci-normal soda solution until a permanent pink colour

forms. Now add distilled water to the mark SS. Again add a few more drops of the phenolphthalein indicator and formaldehyd solution up to the mark F, when the red colour should have disappeared. Again add very carefully deci-normal soda sol. until the pink colour reappears. Each one c.cm. deci-normal soda sol. thereby required (after the formaldehyd has been added) corresponds with .0017 grammes of ammonia, and indicates 1.7 grammes of ammonia per litre of urine.

9. Estimation of Acidosis.

In acidosis the alkaline and carbonic acid of the blood are decreased, and the ammonia of the urine increased; the acid products are neutralised by combination with ammonia at the expense of the urea. A clinical method, therefore, of determining the amount of acidosis is to estimate the urinary ammonia.

(1) Take 20 c.c. of urine; dilute with water. Add a few crystals of neutral potassium oxalate and a few drops of phenolphthalein indicator and titrate with deci-normal solution of caustic soda.

The result $x \times (50)$ equals acidity per litre, due to acid salts and organic acids.

(2) 20 c.c. of urine are placed in a platinum capsule, dried and ashed. The mass is dissolved in distilled water. In normal urine the residue is acid, and titration with deci-normal solution of caustic soda will give the mineral acidity (marked +).

In acidosis the ash is alkaline and titration with solution of sulphuric acid or other acid will give mineral acidity (marked -).

Having these results the total organic acidity equals the ammonia acidity + acidity due to acid salts and organic acids - mineral acidity.—(Journal of Clinical Research.)

Clinical Significance.

This method enables us to detect any perversion of ammonia or alkaline excretions, and shows if the body is being drained of alkalis to any marked extent. It also shows if alkalis should be administered as a medicine or not.

Acidosis occurs in: Diabetes, gastro-intestinal disorders of young children, delayed chloroform poisoning, drugs as sodium salicylate, morphia, phosphorus.

10. Indican.

Solutions required:

- (1) Chloroform.
- (2) Obermayer's Reagent [2-1000 parts of ferric chloride in concentrated hydrochloric acid].

Fill the "Quantitest" Indicanometer with commercial chloroform up to the mark C; add urine to the mark U, then Obermayer's reagent up to the mark R. Close the tube with the thumb and shake vigorously for 15 seconds. If indican be present, indigo blue will be liberated and dissolved in the chloroform. Allow the chloroform to settle, and read off the amount of indican as O, trace + and +++ according to the intensity of the blue colour. This is a good substitute for the long, tedious quantitative estimation at present in use. It will be found to give perfectly satisfactory comparative results.

Note.—If albumin is present it must be removed by boiling, as it will give a blue colour with HCl.

11. Oxidising Power of Urine.

Careful experiments have shown that normal urine requires for its complete oxidation an amount which may be expressed in figures corresponding with the quantity of a deci-normal permanganate of potash solution required for the total oxidation of 1 grm. of urine.

To determine the oxidising power of urine, take 1 c.cm. of urine and 9 c.cm. of distilled water, and heat to boiling point with 25 c.cm. of 50% solution of sulphuric acid. To this mixture a deci-normal solution of permanganate of potash is added until the same retains red colour when boiling. Now 10 c.cm. of deci-normal solution of oxalic acid is added, and the colourless liquid again treated with deci-normal solution of permanganate of potash until the red colour persists.

The total quantity of deci-normal solution of permanganate of potash minus the quantity of deci-normal solution of oxalic acid is multiplied by .0008 (the quantity of oxygen available from 1 c.cm. of deci-normal solution of permanganate of potash).

The numbers for normal urine are between 4 and 11; above 11 are pathological, and higher than 13 are only found with diabetic patients.

12. The Total Solids.

May be estimated approximately by multiplying the last two figures of the specific gravity by 2.33 (Häser's coefficient). This gives the solids in grammes per 1000 c.c.

The amount for the whole 24 hours' specimen can then be readily determined.

Thus, if 1500 c.c. of urine is passed in 24 hours, the total solids = $\frac{20 \times 1500 \times 2.33}{1000} = 69.9$ grms.

Note.—This method can not be applied to urine containing sugar or albumin.

IV.—THE URINARY SEDIMENTS.

UNORGANISED.

Calcium Oxalate.
 Uric Acid.
 Urates.
 Triple Phosphates.
 Calcium Phosphates.
 Calcium Carbonates
 Cystin
 Leucine
 Tyrosine

} Rare
 } Deposits.

ORGANISED.

Epithelium, from the Urethra,
 Vagina, Bladder and Kidney.
 Leucocytes (Pus Cells).
 Red Blood Corpuscles.
 Casts—(a) Epithelial.
 (b) Blood.
 (c) Fatty.
 (d) Granular.
 (e) Hyaline.
 (f) Amyloid.
 Spermatozoa.
 Micro-organisms.
 Pieces of Neoplastic Growths.
 Prostatic and Urethral Threads.
 Fat Globules.
 Bilharazia Hæmatobia.

Sediments found in Acid Urine.

Uric Acid.	Leucine.
Urates.	Tyrosine.
Calcium Oxalate.	Calcium Phosphate.
Cystin.	

Sediments found in Alkaline Urine.

Phosphates.	Calcium Carbonate.	Ammonium Urate.
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CHEMICAL EXAMINATION OF DEPOSITS.

Heat the Sediments	{	Solubles { Urates.
	{	Insolubles { Phosphates. Uric Acid. Calcium Oxalate. Organised Sediments.
Heat the Sediment and add few drops of Acetic Acid	{	Solubles { Phosphates. Carbonates.
	{	Insolubles { Uric Acid. Calcium Oxalate. Organised Sediments.

MICROSCOPIC EXAMINATION OF DEPOSITS.

Allow the urine to stand in a conical vessel for some hours or centrifuge for 3 or 4 minutes. Pipette off the clear urine above the deposit. Remove a small drop of the deposit, and place it on the centre of the slide and cover with a cover glass. Examine with a high power or oil immersion lens. Spread out another portion of the deposit and allow it to dry, and stain with methylene blue, or by Ziehl—Nielsen's method.

MICROSCOPIC APPEARANCE.

- (1) *Uric Acid*: Four-sided rhombic table, rosette, dumb-bell or whetstone-shaped crystals of a reddish yellow hue.
- (2) *Calcium Oxalate*: Envelope-shaped crystals, insoluble in acetic acid but soluble in hydrochloric acid.
- (3) *Triple Phosphates*: Coffin lid, knife rest, or feathery star-shaped crystals. Soluble in acetic acid.
- (4) *Calcium Phosphate*: Amorphous. Soluble in acetic acid.
- (5) *Magnesium Phosphate*: Longitudinal plates. Soluble in acetic acid.
- (6) *Urates*: Amorphous.
- (7) *Ammonium Urate*: Thorn-apple spherules.
- (8) *Cystin*: Hexagonal plates.
- (9) *Tyrosine*: Colourless needle-shaped crystals arranged in sheaves.
- (10) *Leucine*: Crystals arranged in spheres.
- (11) *Calcium Carbonate*: Biscuit-shaped crystals. Soluble in acetic acid with effervescence.

V.—SOME DRUG REACTIONS IN URINE.

Antipyrine: Liq. ferri perchlor gives a brownish red, not disappearing on heating.

Carbolic Acid: Liq. ferri perchlor gives a purple.

Copaibæ: Add a few drops of hydrochloric acid to urine in a test-tube. Copaibæ gives pink colour.

Iodides: Add hydrochloric acid, and a few drops of chloroform; shake. The chloroform takes up the liberated iodine, becoming violet.

Rhubarb and Senna: Add liq. potassæ to urine, which is a reddish brown colour. The red colour deepens. Now add hydrochloric acid, and it becomes yellow.

Salicylates and Salol: Liq. ferri perchlor gives purple colour, not disappearing on heating.

Santonine: Liq. potassæ added to the urine turns the bright yellow colour of the urine to a bright pink.

Urotropine: Liq. potassæ and a few grains of resorcin added to urine gives red colour.

Analysis of Stomach Contents.

I.—THE EXAMINATION OF THE FASTING STOMACH.

This is especially useful as a first step in the investigation of cases in which there is a suspicion of serious disease. Not only shall we obtain valuable information as to the motor functions of the stomach, but even possibly special indications which the chemical examination of a test meal cannot afford.

Method of performing the test.—At 7 p.m., preferably after the stomach has been washed out, the following test meal should be given.

TEST DINNER.

A plate of soup, 2 or 3 ozs. of lean meat, a slice of plain white bread, a medium-sized boiled potato, a couple of tablespoonfuls of puree of spinach or other green vegetable, and a tablespoonful of strawberry or raspberry jam, and a little milk pudding. A glass of water as a beverage.

If the jam and spinach are tolerated they are useful as being easily recognised in the stomach contents when there is retention.

The next morning fasting as much of the contents of the stomach as possible are removed by means of a stomach tube and aspirator. If nothing comes away, the stomach should be washed out and the wash-water put into a tall glass to sediment.

Clinical Indications.

With respect to the results obtained by this examination, we may divide our cases into four groups: the stomach may be empty; it may contain neutral or alkaline contents; it may contain hydrochloric acid; or there may be present lactic or organic acids. Each of the last three groups may be again subdivided into those which contain food residues and those which do not.

1. *The stomach is empty.*—We are justified in arriving at the following deductions:—

(a) There is no considerable motor insufficiency of the stomach, as we know that the stomach is able to empty itself in 12 hours. In order to ascertain whether a lesser degree of loss of motility is present we must examine the stomach six hours after a mixed meal. We can thus practically exclude pyloric or duodenal stenosis.

(b) We can exclude permanent hypersecretion of gastric juice, and thereby probably gastric duodenal ulcer. Consequently, any excess of HCl. which we may find in our

subsequent investigation must be alimentary—that is, limited to the digestive period.

(c) We can probably exclude cancer of the stomach.

2. *The fasting stomach contains a small quantity of neutral or alkaline fluid with or without pus, blood, or infusoria.*

(a) A simple neutral or alkaline fluid containing epithelium and a few leucocytes would suggest achylia gastrica or chronic gastritis.

(b) If pus and blood are present and if we can exclude phlegmonous gastritis (an affection of great rarity) and pus from the mouth, tonsils, post-nasal space, or bronchi, there is in all probability an ulcerating cancer of the stomach. There must, of course, be an ulcerating surface to produce the pus or blood, and a non-malignant ulcer would hardly be found except in association with hydrochloric acid.

(c) The presence of infusoria in addition would make our diagnosis practically certain, and we should also be in a position to say that the cancer was situated upon the wall of the stomach and not at one of the orifices. Two varieties of protozoa are found in the stomach—the *trichomonas hominis* and the *megastoma entericum*—when the four conditions are present which are necessary for their existence. These are absence of HCl, an alkaline reaction, pouches or folds in the gastric mucosa, and absence of fermenting food residues. These conditions are only present in interstitial carcinoma of the stomach.

3. *The stomach contains hydrochloric acid.*—There may be no remnants of food or macroscopic or microscopic food residues.

(a) There are no food residues. If the hydrochloric acid is small in amount, and only occasional, the stomach is probably normal, as it is not unusual for the healthy fasting stomach to contain a little fluid of a low specific gravity with some free hydrochloric acid, as the secretion may be quite accidental and due to some temporary irritation or psychic excitation of the gastric glands. If the hydrochloric acid is invariably present or in larger amounts there is hypersecretion of gastric juice. Such a condition may be rarely a neurosis, or more probably due to ulcer of the duodenum or the irritation of gall-stones or of a diseased appendix.

(b) Hydrochloric acid with macroscopic food residues nearly always denotes an ulcer of the stomach or duodenum which has produced some amount of pyloric stenosis.

(c) Hydrochloric acid with microscopic food residues.—Whenever hydrochloric acid is found in the fasting stomach the problem is to say whether we have to do with a simple hypersecretion of central or reflex origin, or one due to the local irritation of retained food residues. The absence

of macroscopic food residues is far from being conclusive that food is not retained abnormally in the stomach. Sarcinæ and yeast cells in chains or budding are in themselves strong presumptive evidence of food stagnation. If in addition we find muscle fibres, starch granules, fat globules, or crystals, we can be certain that there are food residues retained in the folds and rugæ of the stomach, possibly slight in amount, yet sufficient to set up hypersecretion. Sarcinæ are practically never found in the stomach unless there is hydrochloric acid, and denote either benign stenosis of the pylorus, or a carcinomatous ulcer in the early stage before the secondary gastritis has made much progress. As the atrophic changes develop in cases of cancer there will be observed a gradual diminution in the hydrochloric acid and sarcinæ with a proportionate appearance of the long bacillus and lactic acid. Consequently, if we find both degenerated sarcinæ together with the long bacillus we may deduce that the cancerous growth is a rapid one. As sarcinæ require some time to grow, their absence does not exclude stagnation of short duration.

4. *We find food residues with the presence of lactic acid and possibly the Oppler-Boas or long bacillus.*—A practised observer can usually tell as soon as he looks through the microscope whether the gastric stagnation is associated with the presence of lactic or of hydrochloric acid respectively. In both cases you will see the same changes in the muscle fibres, in both you will often find yeast cells in chains, but if lactic acid be present the protoplasm of the leucocytes will be shrunken and granular, the cells still retaining a faint definite outline; if HCl is present the leucocytes will be entirely digested, leaving only centrally-grouped nuclei. Also with lactic acid you may find the long bacillus, with HCl. sarcinæ, and hardly ever the reverse.

It is important to bear in mind that the long bacillus is not diagnostic of malignant disease, but merely signifies food stagnation with absence of hydrochloric acid and presence of lactic acid. Recent work appears to point to the fact that the long bacillus is only suggestive of malignant disease when accompanied by a considerable amount of lactic acid. The reason is that whilst with ordinary albumins these bacilli form little acid, they find in the cancer albumins thrown off as the result of ulceration a medium which enables them to do so in large quantities. It is obvious, therefore, that the long bacilli associated with large amounts of lactic acid will point to malignant disease which has ulcerated. The long bacilli, which, according to Heineman and Hefferan, are identical with the Bulgarian bacillus, when present in large numbers frequently pass into the intestines and may be recovered from the stools by the same technique.

Macroscopic food residues show us that the stomach is

unable to empty itself during the night and signify some obstruction in the pylorus or duodenum. The association of lactic acid points to its probably being of a malignant nature.

If the food residues are microscopic it is probable that we have a cancer infiltrating a small portion of the wall of the stomach. The immediate effect of this is a local loss of motility, which will increase *pari passu* with the extension of the affected area. At last a stage will be reached when the movements of that part of the stomach wall are not sufficient to dislodge the mucus with which it is covered, and food particles will lodge in the rugæ and on the surface.

II.—THE EXAMINATION OF THE STOMACH CONTENTS AFTER A TEST MEAL.

1. The Test Meal.

In order to obtain the stomach secretions it is necessary to stimulate the stomach functionally, and for clinical purposes we must rely upon the stimulus of food as given in the different test meals. It is necessary to give test meals of known amount and composition, and to withdraw them from the stomach after a certain time has elapsed.

The test meal should be daintily served and every effort made to render it as appetising as possible. Pawlow has shown that the glands of the gastric mucosa are stimulated to a greater degree by appetising food eaten under pleasant surroundings.

The test meal should always be taken on an empty stomach, preferably in the early morning, the usual evening meal of the previous day having been omitted. A test breakfast is preferred to a test dinner or supper, as free hydrochloric acid is more often found in the morning and the results are more uniform.

TEST BREAKFAST OF EWALD.

Seventy grammes of ordinary bread and a glass of water or weak tea. One and one-half ounces of well-baked toast or zwieback is even better. The water should not be taken until after all the bread is eaten. Remove one hour from the time eating is begun.

TEST BREAKFAST OF BOAS.

One ounce of rolled oats is added to a quart of water, with salt to taste, and boiled down to one pint. This meal is used in cases of suspected gastric carcinoma, where a special test for lactic acid is desired.

SALZER'S¹ DOUBLE MEAL.

This authority considers that we may save time by giving the test dinner at 9 a.m., and Ewald's test breakfast at 1 p.m., and extracting the stomach contents for examination an hour afterwards. By this procedure we shall have the advantage of finding out whether the stomach is able to digest and dispose of the first meal in four hours, and shall have the second meal of quite distinct materials for subsequent chemical examination. Salzer's menu is substantially as follows: Breakfast consists of 30 to 50 grms. of cold roast meat, free from fat and skin and cut into dice; 250 grms. of warm milk or milk and water; 30 to 50 grms. of toast or zwieback. Five hours after this meal he gives 30 to 50 grms. of stale wheat bread without crust or toasted particles, and 300 grms. of warm water or tea without sugar and milk. One hour afterwards the stomach contents are to be extracted. We thus get both meals during the height of their respective digestion.

In the clinic of the University of Baltimore, Hemmeter uses a double test meal, which, slightly differing in details, has the same essential features as that used by Salzer. Easily recognisable substances are given at two meals, the first one of which taking three or four hours and the second one hour to digest.

HEMMETER'S DOUBLE TEST MEAL.

At 8 a.m. One small piece of beef, scraped and broiled = 80 grms., one soft-boiled egg, 30 grms. of boiled rice, one glass of milk = 230 c.c., and a piece of bread. Four or five hours later an Ewald test meal is given.

Both Salzer's and Hemmeter's meals enable one to form a very good idea as to the digestion in and motility of the stomach by a simple macroscopic examination.

Care should be taken that no food or drink is taken immediately before a test meal is administered or until after it has been withdrawn.

2. The Stomach Tube.

I consider the Gentile tube the best at present procurable. It is provided with an expansion or "pavilion" at the proximal end in order that it may take a large glass connecting tube or fit over the nozzle of the aspirator. The best sizes for clinical use are Nos. 30 and 32 on the French scale, in which the numbers denote circumference in millimetres.

¹ Salzer, "Journal of the American Medical Association," 1896, No. 2, p. 68.

3. The Removal of the Test Meal.

Noting the time the meal was begun, the necessary preparations are made to remove the stomach contents at the end of one hour. Little, if any, exercise should be taken during the time of digestion; and if, for any reason, there is a possibility of the stomach emptying itself too soon, the patient should lie down on the left side and be quite quiet. At the end of an hour the patient sits, protected with a rubber cloth, with the body bent forward. The mouth is opened, and the distal end of the tube, previously dipped in water, is placed far back in the pharynx. The patient is now asked to swallow, and the tube is quickly passed down into the stomach. If the patient breathes deeply and rapidly during the introduction of the tube, there will be little or no retching or choking.

It must be distinctly understood that it is useless to remove the contents of the stomach by lavage if we wish to subject them to a chemical examination, as the addition of water would entirely vitiate our results. The expression method still advocated in some of the text-books may be mentioned only to be condemned.* The only practical method is by aspiration. The best apparatus for this purpose is, I think, the aspirator of Rosenau, or the equally efficient and less complicated one of Dr. Senorans, which I use exclusively myself. (Sold by Gentile, 49, Saint Andree-des-Arts, Paris.)

The material obtained should be now submitted to a physical examination.

4. Physical Examination of the Stomach Contents.

This should comprise the colour—normally a light straw—the degree of disintegration of the solids, the odour—whether there is an odour of butyric or acetic acids, alcohol or of putrefaction—and the presence of obvious fermentation. The ordinary test meal on standing separates, the undigested particles falling to the bottom. When fermentation is present, a portion of the sediment rises—carried up by the bubbles of CO_2 .

By **simple inspection** combined with a **microscopical examination** we may form a very correct idea of the process of digestion without undertaking any chemical or other tests. And this we shall find especially useful when we are only able to obtain very small quantities of the stomach contents.

For instance, after a test meal consisting of meat and bread—

(a) If we find very few unaltered starch granules, but that the meat fibres have nearly all lost their transverse striation, digestion is proceeding normally, and there is nothing wrong with the gastric secretion.

(b) If we find the starch unaltered, nearly all the bread present in a finely-divided condition, but the meat fibres practically all digested and gone, we most probably have to do with a case of hyperchlorhydria.

(c) When the starch digestion is evidently good but the meat practically unaltered, we have a case of hypochlorhydria.

(d) Starch granules, mainly unaltered, meat digesting well, with the presence of an abnormal amount of bacteria and sarcinae, would point to the probability of the case being one of non-malignant stenosis of the pylorus.

(e) Starch digested, meat unaltered, excess of bacteria, especially the Oppler-Boas bacillus, no sarcinae: probably malignant disease of the stomach.

Hemmeter claims to get from his double test meal the following diagnostic information:—

“Disappearance of the entire breakfast meal points to a normal digestion.

“Absence of all proteids—beef and egg—and presence of considerable carbohydrates—rice and bread—points to hyperchlorhydria.

“Absence of all carbohydrates, and absence of some of the beef and egg, point to hypochlorhydria, sub-acidity, anachlorhydria or achylia.

“Presence of the entire meal, with perhaps milk uncurdled, means impaired motility, with atrophy of the gastric mucosa, absence of acid, enzymes, and pro-enzymes.

“If the entire meal has disappeared, the status of the gastric secretions may be ascertained from the Ewald test meal which is still present.”

The most important point, however, to estimate is the amount of fluid recovered from the stomach, as it affords a rough but valuable index of the motility. In hypermotility the stomach will be emptied sooner than normally, whilst in atony the reverse will obtain, and at the end of the hour there will be obtainable stomach contents in excess of the normal (50 to 150 c.c.). A source of fallacy is the presence of hypersecretion of gastric juice as in this condition a larger amount than normal will be extracted at the end of the hour. The distinction may be made by Elsner's method.

5. Differential Test for Atony of the Stomach and Hypersecretion. (Elsner.)

After having extracted as much of the result of the test meal as possible, it is first of all necessary to calculate how much remains behind in the stomach. This is easily done by the method of Mathieu and Remond. The acidity of the portion of the test meal (*v*) first extracted is estimated

by the method to be presently described and designated by (a). A known quantity of water (q) is now introduced into the stomach, well mixed up with what remains there. Some of the mixture is now extracted and its acidity (a^1) again taken. Then the total volume of the stomach contents at the time of exploration that will be given will be represented by the formula:

$$v + \frac{a \times q}{a - a^1}$$

Having estimated the total quantity remaining in the stomach, we wash it out until the washings come out clear, and put all the extracted material and wash-water mixed together, in tall, narrow, graduated jars to settle. After 24 hours the amount of solid residue can be read off in cubic centimetres. Elsner finds that normally this should vary between 30 and 100 c.c. If it is increased in relation to the total amount remaining in the stomach, the diagnosis will be motor insufficiency.

The diagnostic significance will be as follows:—

- (a) Total amount in stomach increased, residues normal: diagnosis will be hypersecretion.
- (b) Amount in stomach normal, or slightly raised, residues increased: diagnosis will be deficient motility such as would be met with in atony.
- (c) Amount in stomach largely increased, and residues increased: diagnosis is atony + hypersecretion.

In ordinary cases these tests are usually omitted, and we proceed at once to filter the stomach contents which we have obtained with a view to their chemical examination. Incidentally we notice the rapidity of filtration as affording a clue to the presence of mucus. Slow filtration points to an excess of mucus, which is a certain sign of chronic gastritis.

6. Total Acidity and Free Hydrochloric Acid.

Congo red paper colours blue if free HCl. is present. Organic acids colour brownish black. Mixture of HCl. and organic acids dirty bluish black.

Günzberg's Test—Dissolve a tablet of Günzberg's test in a few drops of alcohol in a porcelain dish; add an equal quantity of the filtrate of stomach contents, and heat gently. If HCl. is present in the free state, there forms a red ring at the edge of the drying solution.

In all estimations of acidity it is usual to express the results as the number of c.c. of deci-normal sol. of sodium hydrate required to neutralise 100 c.c. of gastric juice, multiplying the number of c.c. of soda solution used to neutralise the 10 c.c. of the filtrate used by 10. To obtain the absolute number of grammes of acid per cent. estimated

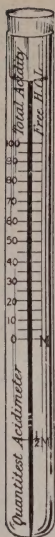


Fig. 7.

as HCl, we must multiply the number of c.c. used to neutralise 100 c.c. of the filtrate by .00365. Using the acidometer supplied with the gastrotect, we find both these calculations done for us, the cylinder being marked on the left side yellow scale in degrees of acidity on the deci-normal scale and on the right with the corresponding amounts of HCl. per cent.

Method of performing the test.

Pour filtrate of stomach contents into the acidometer up to the mark M (10 c.c.). If the quantity obtainable is insufficient, fill up to $\frac{1}{2}$ M and up to the M with water, the finding of course being doubled. Two drops of the indicator are now added, and deci-normal soda solution is added drop by drop with a dropping pipette. After each addition of NaHO, the tube should be inverted without shaking. On first adding the indicator to the filtrate in the acidometer a beautiful red-currant colouration will appear if there is any free HCl. present. On the addition of the soda solution, this colour will gradually disappear, and one of two things will happen.

(a) An orange colour will be produced if organic acids of fermentation are present.

(b) A yellow colour if these are absent.

In each case the reaction is finished as far as the free HCl. is concerned, and the degree of acidity can be read off, the height of the column of fluid denoting the amount of free HCl. present, expressed on the left-hand scale in degrees of the deci-normal soda scale and on the right hand in the absolute percentage of free HCl.

Having noted this down, the test is continued with the same solution by dropping in more of the soda solution until the orange tint, if present, changes to yellow. The difference between the reading now and that denoting the amount of free HCl. will give the amount of organic acids present. One now continues to add the soda solution until a red colouration appears which does not disappear upon inverting the tube. The height of the column of fluid now will denote the total acidity.

7. Combined Hydrochloric Acid (Robin's Method).¹

We take the acidometer, wash it thoroughly, and fill it with filtrate of the stomach contents up to the M mark. We now introduce into it two drops of a 1% solution of

¹ "Les Maladies de l'Estomac," Paris, 1904, p. 47.

hæmatoxylin in alcohol. This indicator remains yellow in the presence of free HCl. and organic acids, is not influenced by the presence of combined HCl., and becomes blue as soon as the former are neutralised. We allow the deci-normal solution of sodium hydrate to fall drop by drop into the tube as before, and read off the height of the column of liquid as soon as a distinct tinge of blue appears which does not disappear on inversion. The degree of acidity now disclosed subtracted from the total acidity obtained in paragraph 6, will give the amount of combined acid.

An example will make this plain.

Let us suppose that in the first operation the red colour changed to orange when the liquid stood at 20 in the tube (H, free HCl.=20), the orange colour became yellow when the liquid stood at 25 (F, organic acid, $25 - 20 = 5$), and the red colour permanently reappeared when the liquid stood at 60 (A, total acidity = 60).

As the result of this operation we have:

A (total acidity) = 60.

H (free HCl.) = 20.

F (fermentation or organic acid) = 5.

We perform the second operation, and find that the blue colour becomes permanent when the liquid stands at 25.

$A (60) - H (20) = C (40)$ the amount of combined acid.

And we can check our original rough estimation by colour, of the amount of organic or fermentation acids, by the equation:

$H (20) + F (5) = C (25)$ the amount of organic acids.

In this estimation the amount of phosphate acidity has been neglected, which will slightly lower the degree of combined HCl.

8. Hydrochloric Acid Deficit.

In cases in which there is no free HCl. present the addition of the indicator to the filtrate will produce a dirty yellow colour instead of a clear red. By the addition drop by drop of a deci-normal solution of HCl., we shall reach a point at which this red colour appears. The height of the column will then denote upon the scales the amount of HCl. deficit.

The compound indicator used in the above tests is that known as Linossier's, and has the following formula:

Dimethylamidoazobenzol, 0.25 grms.

Phenolphthallein, 2 grms.

90% alcohol, 100 grms.

Clinical Indications from the amount of HCl.

The HCl. content of the gastric juice:

(a) If normal there may be respectively a normal stomach, simple atony of the stomach of insufficient severity to lead to retention of food residues, pyloric stenosis not sufficient to delay materially the emptying of the stomach, or a pure neurosis.

(b) Increase of HCl. acidity. We may have nervous hyperchlorhydria, acid gastritis, a gastric or duodenal ulcer, a gall-stone, or a latent appendicitis.

(c) Diminution of HCl. This may result from a general condition, such as neurasthenia or anæmia, from a chronic gastritis, or from malignant disease of the stomach.

(d) Absence of HCl. This is always a most important symptom. Rarely a neurosis, it practically always denotes either the terminal stage of a chronic gastritis or atrophy of the secreting glands either of benign or malignant origin.

9. Test for Lactic Acid.

Of the different methods which have been proposed, that suggested by Straus is undoubtedly the best we have at present and sufficient for practical purposes. It not only avoids the fallacies of the Uffelmann's reaction, but also gives us an idea as to the amount of lactic acid actually present.

The filtrate of the stomach contents is poured into a Strauss separating funnel up to the 5 c.c. mark. Ether is added up to the 25 c.c. mark. After the tube has been shaken vigorously for a few minutes it is placed upright in a rack until the ether has risen to the top. The stop-cock is now opened and the lower layer (stomach contents) allowed to escape. Distilled water is now to be poured into the funnel until the level of the liquid again reaches the 25 c.c. mark. 2 minims of a 10% solution of ferric chloride are now added and the apparatus shaken. After the layers have again separated if more than 1% of lactic acid be present the lower stratum (the distilled water) will be coloured a greenish yellow.

10. Test for the Products of Starch Digestion.

An hour after a test breakfast containing the usual quantity of starch, so much of this should have been converted into achrodextrin, maltose and dextrine, that the erythrodextrin reaction with iodine should be absent. The presence of erythrodextrin in any quantity will point to hyperchlorhydria, as according to Boas¹ 0.7% of HCl. will

¹ Boas, "Diagnostic u. Therapie der Magenkrankheiten," p. 19.

check, and .13% will arrest the diastatic action of the saliva.

Erythrodextrin strikes a brown colour with Lugol's solution (iodine, 3 grs.; potas. iod., 6 grs.; water, 6 ozs.).

Clinical Indications.

As a general rule the extent to which starch digestion is carried out in the stomach may be taken as a confirmation of our findings as to the amount of free HCl, being in inverse ratio to it. The chief practical use of ascertaining whether starch is digested in the stomach is to guide us in the selection of a suitable diet.

11. Test for the presence of Rennin and Rennin Zymogen.

Add a few drops of the filtrate to 2 or 3 c.c. of milk in a test tube, and keep it warm for 15 minutes in a tumbler of water at about 37°C. If coagulation takes place within that time, rennin is present; if not, then it is absent. In the normal stomach the rennin is not secreted as such, but as an inactive pro-enzyme, which is converted into the active ferment rennin by the action of the HCl of the gastric juice. In cases where the HCl is deficient we naturally find the rennin absent as well. The zymogen, however, may be present, and it is important sometimes to test for it. Rennin zymogen has not the power of coagulating milk, and we must therefore convert it into rennin before we can discover it. We cannot use HCl. for this purpose, as it also can curdle milk. Fortunately we have in calcium chloride a substance which is capable of converting rennin zymogen into rennin. We add 1 c.c. of a 10% solution of calcium chloride to 5 c.c. of the filtrate of the stomach contents, which has been rendered slightly alkaline, if it is not already so. Keep the mixture warm for a few minutes, and then test as before by taking a few drops of this and adding to 2 or 3 c.c. of milk. Coagulation after 15 minutes will demonstrate the presence of the rennin zymogen.

12. Quantitative Estimation of Rennin.

Cohnheim's directions for performing the dilution method cannot be improved upon, and are as follows:¹

1 c.c. of filtrate of stomach contents is measured with a pipette and dropped into a 10 c.c. measure glass. Tap water is added up to the 10 c.c. mark. After having well shaken up the mixture, pour one half into a test-tube marked 1/10 with a grease pencil (Dermographic pencil). Water is added again to the portion remaining in the measure glass to the 10 c.c. mark, well mixed,

¹ Cohnheim, "Die Krankheiten des Verdauungskanal," Berlin, 1908, p. 24.

and a half poured into a second test-tube marked 1/20. The process is repeated in each case pouring the half of mixture in the measure glass into test-tubes marked respectively 1/40, 1/80, 1/160, and 1/320. In each test-tube is now introduced 5 c.c. of milk and $2\frac{1}{2}$ c.c. of a 1% solution of calcium chloride. After having been all well shaken the tubes are stood in a vessel of warm water together with a control tube containing only milk and chloride of calcium solution in equal parts, with no stomach contents at all.

Normally there should be complete coagulation in the tube marked 1/160. In the next following tube, that marked 1/320, the curd should be in flakes. With hyperchlorhydria higher degrees of dilution are possible in some cases, a dilution of 1/800 giving positive results.

One expresses the result of the test by naming the degree of dilution in which flocculent or solid curdling respectively occurs.

Clinical indications according to Cohnheim.

(a) Normal rennin with hypochlorhydria suggests a neurosis and the probability of eventual return of the gastric juice to normal.

(b) In hypochlorhydria the presence of a reduction of the rennin to 1/100 suggests chronic gastritis and the prognosis should be also good with proper treatment.

(c) Under the same circumstances a reduction to 1/40 would suggest an interstitial gastritis, and one to 1/10 or lower a total atrophy of the gastric secreting glands.

13. Estimation of the Pepsin.

Boil an egg hard, cut from the white a thin slice, and from this punch some discs with a cork borer or with the barrel of a steel pen. Place several of these discs in a test-tube and half fill with the filtrate of the stomach contents. Stand in a tumbler half full of warm water. After two hours examine with the biuret test.

(a) There is no reaction. Neither pepsin nor HCl. are present.

(b) The white of egg is dissolved and the test gives a violet colour. HCl. only is present.

(c) The white of egg is dissolved and the reaction with the biuret test is purple red. Both pepsin and HCl. are present.

If we know from our previous tests that HCl. is not present, we may add a little to the filtrate in the tube. In this case if we get the violet reaction we know that pepsin was absent. If present we shall have the purple red colouration produced.

The violet colour is produced by acid albumen in solution. The red purple colour signifies albumose mixed with peptone, but is sufficiently near for practical purposes. To get the pure rose colour of peptone alone, you would have to first throw down the albumose with excess of ammonium sulphate, let stand for 24 hours, and then filter. The biuret test is performed by mixing with an equal bulk of solution of caustic potash and then adding a few drops of a 2% solution of cupric sulphate.

If a thermos flask is at hand, it may be used with advantage instead of the tumbler of warm water, the test-tube being corked and kept immersed by pressure from the stopper.

14. Hammerschlags Method of Pepsin Estimation.

10 c.c. of acid albumin solution are poured into each of two test-tubes A and B. To A is added 5 c.c. of the filtrate of the stomach contents, and to B the same quantity of distilled water. Two Esbachs tubes are filled respectively from A and B up to the U mark. They are placed in an incubator or its equivalent (Thermos flask) and kept at about 37°C. for one hour. They are now removed and filled up up to the mark R with Esbach's solution, well shaken, and stood upright in a test-tube rack for 24 hours.

At the end of that time the difference in the height of the lower layer will represent the amount of albumin dissolved in that hour, during which incubation was proceeding.

Composition of the acid albumin solution.

- 30 c.c. raw white of egg.
- 4 c.c. HCl. solution 25%.
- 250 c.c. of tap water.

Put the white of egg into a beaker and add the HCl. solution very slowly drop by drop with frequent stirring. Filter through a linen cloth on a funnel.

The result is expressed by reducing the difference to percentages.

For example: If the layer stands in the first tube at 2 and in the second at 4, the amount digested has been:

$$4 - 2 = 2 = \frac{1}{2} \text{ of } 4, \text{ i.e., } 50\%.$$

Hammerschlag gives the normal as from 70% to 80%. In hyperchlorhydria one may find the reading as high as 95, and in hypochlorhydria as low as 10% or under.

Alternatively the incubation may be carried out in the original tubes A and B, and the albumin estimated by the improved method given in the chapter upon the examination of the urine.

15. Test for Mucus.

The amount of mucus may be roughly estimated by the rapidity of filtration of the stomach contents. When we wish to know at all accurately whether the gastric mucus is in excess, we should search for it in the morning when the stomach is presumably empty. Using a large funnel, we allow the same wash-water to run backwards and forwards several times before we finally syphon it off. It is possible, quite apart from its quantity, to ascertain whether the mucus in any given case is normal or whether it is a symptom of gastritis. Normal mucus stains only very faintly with methyl green, and when treated with acetic acid swells up but does not precipitate. *Per contra*, the mucus met with in chronic gastritis after the transformation of the cylindrical epithelium into goblet cells stains intensely with methyl green, and is precipitated by acetic acid.

16. Tests for Blood.

It frequently happens that it is necessary to test for the presence of blood in the stomach contents. The test usually advocated, that with guaicum and ozonic ether, is unreliable unless performed with special precautions, which unfit it for clinical use. The best methods of recognising blood in the stomach contents are:

(a) Simple microscopical demonstration of the red corpuscles.

(b) The Prussian blue test. Take a little of the sediment from the filter paper through which the stomach contents have been passing, and place it in a porcelain capsule with a pinch of powdered chlorate of potash. Add a drop of strong HCl. and evaporate at a gentle heat. You repeat the addition of the HCl. and the subsequent heating until the residue is colourless. You then add a drop of a 1% solution of ferrocyanide of potassium. If blood be present Prussian blue will be formed. It is needless to remark that neither underdone meat as food nor iron as medicine must have been taken for some hours before this test. The heating should have been done slowly and gently, preferably upon a sand bath.

(c) As a confirmation test we may manufacture, from the sediment containing blood, hæmin crystals, as suggested originally by Teichmann, and recognise them under the microscope. This well-known test is formed as follows: Evaporate a small quantity of the sediment almost to dryness in a porcelain dish. Place a tiny particle

upon a microscopic glass slip, with a little common salt and a drop of glacial acetic acid. Put on a cover-glass and heat over a spirit lamp until bubbles commence to form. If blood be present, the characteristic reddish, rhomboidal crystals of hæmin will be seen on microscopical examination. This test has failed in several cases where blood was known to be present. It should not, therefore, be relied upon as proving the absence of blood, but only used as a confirmation test when the Prussian blue test has shown it to be present.

(d) We may use the benzidine test given in the examination of the fæces.

17. Fermentation Tests.

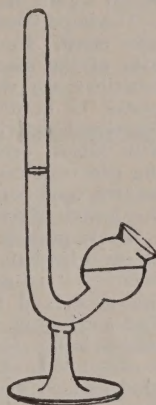
In cases of retention of food residues we may derive valuable information from the rapidity of gas formation. We can ascertain this in the following manner: We finely divide some freshly-extracted stomach contents, and fill with it a fermentation tube and stand in a warm place.

(a) In the normal stomach there will be very slight gas formation in several days.

(b) Gas formation in a few hours will probably indicate stenosis of the pylorus.

(c) Gas formation occurring only after a few days will denote that there is probably dilatation of the stomach without stenosis.

The fermentation tube figured above has a capacity of 20 c.c., and is made specially for the purpose.



18. Bile Pigment.

Take 5 drops each of a 1% aqueous solution of sulphanic acid and a 1% sodium nitrite solution. Mix in a test-tube with an equal bulk of the liquid to be examined. If bile pigment be present the mixture becomes ruby-red, which, on the addition of a few drops of HCl, and dilution with distilled water, changes to an amethyst-violet. With acid gastric juice the addition of HCl. is usually unnecessary.)—Krokiewicz, in "Munch. Med. Wochenschr," Oct., 1906.

Analysis of Fæces.

Whilst the examination of the urine and, to a lesser degree, the stomach contents are matters of daily routine, the investigation of the fæces has suffered unwarrantable neglect. This has been due to a multitude of reasons among which we may enumerate, an exaggerated idea of the unpleasantness and difficulty of the task, and the lack of any manual which would point out the tests which are within the range of the practitioner without special knowledge or laboratories, the methods of applying the same, and the value of the information which they would give him in the diagnosis of disease. It is the aim of this chapter to offer a series of tests which, thanks to the labours of Cammidge in this country, Gaultier in France, and others, have been so simplified as to present no greater difficulty and occupy hardly more time than the urinary tests with which we all are familiar.

The importance of the examination of the fæces cannot be over rated. By it alone we are able to form a very good idea of the manner in which the whole of the digestive functions are carried on: whether the fault lies in the gastric or in the intestinal digestion, and to estimate the functional activity of the liver and pancreas. We can with almost certainty diagnose inflammatory affections of the pancreas, can recognise the presence of chronic inflammatory conditions of the intestines, and locate the part of the bowel affected.

Before passing to a consideration of the different methods of investigation, we may premise by saying that to avoid fallacies it is necessary that the patient should take a test meal, and that it should be the fæces derived from that meal which should be submitted to examination. The reason is not far to seek. In our ordinary more or less careless mode of life we habitually consume more of every kind of food than the digestive organs are able to handle. For example, in a man who habitually eats twice the amount of meat that he is able to digest, the finding of meat residues in the stools would mean very little. But, let us reduce that amount of meat to just a trifle less than a healthy body should be able to use, and then the finding of undigested meat remains in the stools will mean a great deal and point to grave defect in the digestive secretions.

1. The Intestinal Test Meal.

The best of these and the most convenient is that devised by Gaultier ("Coprologie Climique," Paris, 1907., p. 314). This consists of

White bread, 100 grms.
Lean beef, 60 grms.
Butter, 20 to 30 grms.
Milk, 300 to 500 grms.
Potatoes, 100 grms.

The beef should be grilled and served with a portion of the butter upon it; the potato boiled, weighed afterwards, and mixed with some of the milk and butter into a puree. The remainder of the milk should be taken as a beverage and the butter with the rest of the bread.

2. The Delimitation of the Fæces Corresponding to the Test Meal.

At the beginning and at the end of the meal a cachet containing 4 or 5 grains (.30 grammes) of carmine should be taken. The stools when passed will be coloured with this substance, and the whole of the fæces corresponding with the test meal can be collected and utilised for examination.

If in any way possible the patient should be placed upon an exclusively milk diet for a couple of days preceding and for a day after the test meal. It will then be exceeding easy to pick out the carmine-coloured fæces from the milk stools which follow and precede them. The colouration of the test meal will incidentally enable us to establish another important clinical point, namely:

3. The Time taken by the Food to pass through the Alimentary Canal.

Normally the time should vary between 24 and 36 hours. Diminution of the period will point to hypermotility of the intestine, diminution in the rate of absorption, or increase in the excitors of peristalsis, or to catarrh or inflammatory processes in the small intestine.

Lengthening in the stay of the fæces in the intestine may be caused by a variety of conditions, such as atony of the intestine, mechanical obstruction to the passage of fæces, diminution in bacterial activity, deficiency in cellulose in the food, and will call for methods of physical examination.

Having obtained a sample of typical fæces, we may proceed to a systematic examination. It will usually be convenient to take first the examination of the functions of the pancreas and to perform the urinary tests which have a clinical bearing upon the diagnosis. [*To avoid repetition these have been omitted from the urinary section.*]

1.—THE EXAMINATION OF THE FUNCTIONS OF THE PANCREAS.

In addition to the utilization of fat (*vide* page 57), we have three tests—two urinary and one fæcal—by which we are able to form an idea as to the functional condition of the pancreas.

1. Cammidge's C Pancreatic Reaction in the Urine.

This test is really quite easy notwithstanding its apparent complexity, the main point being to have the powders ready weighed before commencing the work. For rapid work it is a great advantage to make use of five flasks, as the filtrate can in each case be allowed to run into a fresh clean flask ready for the addition of the next powder, and no washing up need be done until after the test is concluded. But if these are not available, the test can with a little more trouble be readily carried out with one only, the opportunity being taken to wash it whilst filtration is going on.

First of all make sure that the urine is acid and that it does not contain either sugar or albumin. The former if present must be removed by fermentation, the latter by acidification, boiling, and subsequent filtration before the test is attempted.

Measure 40 c.c. of filtered urine into a 100 c.c. flask and add 2 c.c. pure HCl. Insert the funnel condenser and boil gently for ten minutes on the asbestos mat. Cool by allowing water from a tap to run over the surface of the flask held obliquely under it. Add little by little 8 grms. of carbonate of lead. Shake at intervals until effervescence has ceased. Filter into a clean flask. To the filtrate add 8 grms. of powdered tribasic acetate of lead. When the reaction has ceased filter into a clean flask. To the filtrate add 4 grms. of sodium sulphate. Heat to boiling. Cool under the tap. Filter into a clean flask. In this instance filter several times if necessary until the filtrate is quite clear. Pour the filtrate into the graduated cylinder up to the 10 c.c. mark, and fill up to the 17 c.c. mark, with distilled water. Add .8 grms. of phenyl hydrazin hydrochlorate, 2 grms. of sodium acetate, and 1 c.c. of a 50% solution acetic acid. Pour into a clean flask and boil for ten minutes very gently. Whilst this is boiling, heat some distilled water and with it wash out the graduated cylinder and stand it upside down to drain. Filter the hot liquid from the flask into the graduated cylinder through filter paper which has been moistened with the hot distilled water, and add hot distilled water up to the 15 c.c. mark. Replace the stopper in the cylinder and stand aside.

In cases in which the test is positive, a yellow flocculent precipitate will be thrown down in the cylinder, which will be found on microscopical examination to consist of threadlike yellow crystals arranged in sheaves and bundles. These crystals should melt away in from 10 to 15 seconds, when a 33% solution of sulphuric acid is irrigated under the edge of the cover glass.

As the result of a large number of examinations it has been definitely established that a positive pancreatic reaction points to there being active degenerative changes in the pancreas at the time of examination.

2. The Presence of Calcium Oxalate Crystals in the Urine.

The presence of these is important as confirming the diagnosis of chronic pancreatitis, as they are often present in this condition. After centrifugalization, or simply after the urine has stood for some time and deposited a sediment, calcium oxalate crystals may be found microscopically in two forms.

- (a) Octahedral crystals which belong to the tetragonal system and resemble double envelopes or prisms.
- (b) Spheroidal forms, flattened or rounded, often with a central groove.

The crystals of calcium oxalate may sometimes be mistaken for triple phosphate, but may be distinguished by their insolubility in acetic acid.

3. The Pancreatic Insufficiency Test.

This valuable test is based upon the fact that if the pancreas is functioning in a normal manner the trypsin which it will secrete will be in excess of that which is required to digest the proteid present in the food and consequently some will be found in the stools. The presence of trypsin, then, in the stools will demonstrate that the pancreas is certainly secreting enough of its special ferment for practical purposes. Its absence will denote the converse, and suggest either disease of the pancreas or obstruction to its free flow into the intestine.

Trypsin in fæces is demonstrated in the following manner:—

One of the casein powders (.05 grms.) is dissolved by gentle heat in 100 c.c. of 1 in 1000 soda solution in a 150 c.c. flask. The fæces to be examined is rubbed up with three times its bulk of the same soda solution and filtered until clear. 10 c.c. of this filtrate are then added to the 100 c.c. of casein solution in the flask, and placed in an incubator at 38° to 40°C. After 12 hours, a little of the material is withdrawn and tested with a few drops of a 1% solution of acetic acid. A precipitate will be always thrown down as long as there remains any of the casein in an undigested condition. When a precipitate no longer occurs, we know that the digestion is complete. We therefore test at intervals until this no longer occurs, when we shall know that digestion is complete. With the patient upon a proteid diet (with which trypsin is formed in largest quantity), the digestion of the casein should be complete in from 12 to 14 hours.

Clinical Indications.

If digestion takes place in a less period than 12 hours, it suggests the presence of an excess of the pan-

creatic secretion such as occurs in the early stage of chronic pancreatitis, when the affection is still in the catarrhal state. If the digestion takes place in the normal period, it is an argument against there being any serious alteration in the functions of the pancreas such as we meet with in cirrhosis or malignant disease. If the digestion time is increased, a diagnosis of chronic pancreatitis as shown by a positive pancreatic reaction will be confirmed, and a suggestion made that there is present some cirrhosis of the gland from past inflammation.

In connection with the diagnosis of chronic pancreatitis, the reader is referred to the section on the examination of urine for **Indican**. Indicanuria denotes putrefactive changes in the contents of the upper part of the intestine, and suggests that any pancreatitis present has been caused by a duodenal catarrh extending to the pancreatic ducts.

II.—THE EXAMINATION OF THE STOOLS.

These may be divided into two groups, *i.e.*, those performed with moist and those with dried fæces. The former are quite workable as a matter of routine in daily practice, and should be sufficient for diagnostic purposes in the great majority of cases.

TESTS PERFORMED WITH MOIST FÆCES.

MACROSCOPIC EXAMINATION.

After noting the form, colour, and consistency of the dejecta, from each of which points valuable diagnostic information may be derived, a piece the size of a small nut should be ground up with a pestle in a porcelain dish with sufficient distilled water to bring it to the consistency of a thin cream. If the fæces are already liquid, this will not be required. Sufficient of this is poured into a Petri dish to cover the bottom for about an eighth of an inch in thickness. The first thing to do is to obtain the **Reaction** by floating on the surface a piece of red and a piece of blue litmus paper. Bibulous paper must be used, and not the glazed variety. The paper will act as a filter, and a red or blue spot appearing on the back of the papers will show at once the reaction. If both appear, the stool is amphoteric.

The next point is the examination by transmitted light. This can be conveniently obtained by a hand mirror reflecting a lamp, the said mirror being supported at one end by a book or other suitable object. Normally

the mixture should be homogenous and there should be no large particles.

Pathologically we may find **mucus, muscle fibre, connective tissue fibre, potato remains, or large crystals of ammonium magnesium phosphate**, which will grate as we grind up the fæces. Any suspicious particle should be removed for microscopic examination and placed in a beaker of distilled water.

Clinical Indications.

Mucus in the fæces must always be considered as pathological, and to denote either a functional disturbance of secretion or more frequently an anatomical disease. We are enabled to deduce from the appearance of the mucus and the way in which it is mixed with the fæcal matter the part of the intestine from which it comes. Pure mucus without any admixture of fæces denotes catarrh of the rectum, sigmoid, or lowest part of the descending colon. Fæcal masses covered exteriorly by a thin layer of mucus point to constipation, fæcal retention, and irritation, and consequent catarrh of the lower bowel. Mucus, whether macroscopic or microscopic, if intimately mixed with fæces, suggests catarrh of the upper colon, or of the small intestine. If the flakes of mucus are either bile-stained or become green when acted upon by a strong aqueous solution of corrosive sublimate, it may be considered practically certain that they come from the small intestine.

MICROSCOPIC EXAMINATION.

As suggested by Schmidt, we should make three cover-glass preparations, the first with a minute portion of fæces rubbed up with distilled water, or better still, with normal saline solution, the second to which a small drop of a 30% solution of acetic acid has been added and heated, and a third which has been rubbed up with a drop of Lugol's solution. I am in the habit of making a fourth in which the particles of fæces has been rubbed up with glycerine.

By the examination of these we shall be able to determine in pathological cases, **remains of vegetable tissue, undigested starch, undigested gluten, undigested muscular fibres, excess of fat** in the form of needles of fatty acids, soaps or droplets of fat, **crystals of ammonio-magnesium phosphate** denoting intestinal putrefaction, or of cholesterine showing digestive disturbances in the small intestine, of hæmotoidin denoting recent hæmorrhages, **red blood cells, leucocytes, epithelial cells**, infusoria or amæbæ, or **eggs of parasites**. Each of these having clinical significance.

Having gone thus far one should complete the microscopical examination by making a preparation stained with Gram and counterstained with neutral red.

1. Method of making a Gram Stained Specimen.

Take a loopful of the mixed fæces in the Petri dish; place it at one end of a microscope glass slip, 3 in. by 1 in., and with the end of another slip spread it along the slide in exactly the same manner as in making blood films. Dry in the air. Fix by passing three times through the flame of a spirit lamp or Bunsen burner. Make some fresh aniline water by shaking up a little aniline oil with water, filter sufficient on to the slide to cover it, and add a few drops of concentrated methyl violet solution in alcohol.

If the proper amount has been added, a scum should be seen on the surface. Allow it to stand for four minutes. Wash under the tap. Flood with Gram solution. Let it stand one minute, and wash again under the tap. Dry with blotting paper. Flood with absolute alcohol until no more colour comes away. Flood with a 1% solution of neutral red in water. After two minutes wash off, dry in the air, and drive off the last remains of moisture at a distance above the flame. Place a drop of cedar oil upon the film, and examine direct with an oil immersion lense without imposing a cover glass.

In preparations stained with Gram and counterstained with fuchsin or neutral red, the red stained organisms will normally preponderate (the colon bacillus being Gram negative). In abnormal putrefaction, in proportion as the aerobic bacilli are replaced by strict anærobes (most of which are Gram positive), the blue stained organisms will be in excess. It is therefore possible to tell at a glance with a little practice whether there is abnormal putrefaction in the intestine.

This fact was first pointed out by Strasburger,¹ who found the bacteria in the stools of healthy adults to be mostly Gram negative, especially when the diet was largely vegetarian. *Per contra* when the patient was upon a meat diet, he found the number of Gram positive organisms greatly increased.

This point was further insisted upon by Herter,² who lays stress upon the valuable information which one may gain by examination of the Gram stained, cover glass preparations of stools.

"From the use of the Gram method one obtains some idea as to the numbers of micro-organisms resembling the colon bacillus in morphology; one may form a judgment as to the state of their preservation, as to the presence or absence of slender, long, Gram negative organisms of the type of the *B. liquefaciens ilei*; a judgment may be formed as to the numbers of Gram positive diplococci and other coccil forms."

¹ Strasburger. "Zeitschrift für klin. Med.," 1902, 46, p. 413.

² Herter. "Bacterial Infections of the Digestive Tract," 1907, p. 113.

The important studies upon the fæces of healthy men lately carried out in the laboratory of the University of Illinois by Ward, MacNeal, Katzer, and Kerr have placed our knowledge upon the relative frequency of Gram positive and Gram negative bacteria in the fæces upon a more exact basis. The observations were 266 in number and were made upon the stools of twelve healthy men who were being fed upon a carefully selected representative mixed diet. The conclusions arrived at were as follows:—"The Gram stained films were always predominantly Gram negative. The total Gram negative bacteria, not including spores, varied between 97% in Subject J., February 27th, and 63.4% in Subject G., March 4th. The total Gram positive bacteria, including those containing spores, varied from 34% in Subject C., July 27th, to 1.4% in Subject J., February 27th. "*Summary.*—The bacteria of the adult human fæces are Gram negative for the most part, about 70% of all the bacteria being Gram negative bacilli. Gram positive rods are constantly present."

2. Test for Occult Blood.

One of the most marked features of the last two or three years has been the improvement in the technique for detecting minute amounts of blood in the fæces (occult blood), and our tests are now quite delicate enough for all practical purposes.

Among the many tests proposed to demonstrate the presence of small amounts of blood in the fæces, one of the most practical is the following modification of the benzidine test:—

Place as much benzidine as will lie on the point of a penknife in a test-tube (A) and add about 1 or 2 c.c. of glacial acetic acid.

Put a piece of fæces the size of a haricot bean in test-tube (B) and add 4 to 5 c.c. of water. Break it up with a glass rod, plug with cotton-wool and boil. Place 3 c.c. of a 3% solution of peroxide of hydrogen in test-tube (C), and add 10 drops of the benzidine solution from tube (A).

To this add about 5 drops from tube (B). If occult blood be present, a blue or greenish colour will develop within three minutes.

Of course it is best for the patient to have been living upon a diet free from hæmoglobin for two or three days previously, but in practice as long as the meat was in small amount and well cooked, it does not appear to matter to any great extent. If, however, the test is positive, the patient should then for precaution be placed upon a hæmoglobin-free diet for a few days and the test repeated.

The following benzidine test is more complicated, and may be used in cases in which the amount of occult blood is smaller and not so easily demonstrable.

Glacial acetic acid is poured over a fairly large portion of one motion, contained in a glass or porcelain vessel.

The faeces should be stirred up to the consistence of thin broth, with the glass rod provided. This material is then poured, through a funnel containing a porcelain sieve, into a wide-mouthed bottle. If the material does not flow through easily, it is aided by a piece of wood used between the glass funnel and the porcelain sieve. The "extract" can be worked up afresh, or it may be kept for some time.

In order to conduct an examination for blood, 5 c.c. are put into a separating tube, and 25 grm. of carbon tetrachloride (CCl_4) are added thereto, and well shaken; the glass stopper being so adjusted that the little holes are not opposite each other. When a separation into two layers has taken place, the glass stopper is turned into a position wherein the holes correspond with each other, the stop-cock is opened, and the lower layer is allowed to flow, almost entirely, into a porcelain bowl. The bowl is now heated over a wire net, by means of a small flame, until the liquid is evaporated, and then the bowl is placed in cold water. Meanwhile a piece of benzidin, the size of a pea, is well shaken up with 5 c.c. of glacial acetic acid, and dissolved as much as possible. 2 c.c. of this solution are poured into the cooled porcelain dish, and 3 drops of hydrogen peroxide are added thereto. If blood is present, a greenish blue or bluish colouration appears either immediately or in the course of one minute.

Clinical Significance of Occult Blood in the Stools.

As regards the significance of the finding, observers are mostly agreed that a negative result of the test is much more valuable from a diagnostic point of view than a positive one. For instance, in the absence of hydrochloric acid in the stomach contents with no retention of food, the continued absence of occult blood in the stools would go far to negative the suggestion of a gastric carcinoma.

The information to be obtained from the presence of occult blood in the stools, the patient being on a hæmoglobin-free diet, may be briefly stated as follows:

(a) The constant presence of occult blood strongly suggests malignant disease of the stomach or intestines.

(b) Intermittent presence suggests a gastric or duodenal ulcer.

(c) Appearance of occult blood in the stools of a patient who has been apparently cured of an ulcer of the stomach or duodenum strongly points to an impending relapse. As Boas has wisely suggested, all cases of cured ulcer should have periodical examinations of the stools for occult blood for some months until the continued absence of blood shows complete healing.

(d) The test for occult blood is of extreme value to us during the medicinal treatment of stomach or duodenum,

to tell us when it is safe to make any improvement of the diet. Should occult blood appear at any time after an increase of food has been given the patient, it will show that the change has been prematurely made and we must try back for a little.

In any case, the appearance of occult blood in the stools points out that there is some bleeding going on in the gastro-intestinal tract, and indicates the absolute necessity for a thorough examination and investigation of the patient.

3. Test for Bilirubin.

Place a small piece of fæces in a porcelain dish and cover with a saturated solution of corrosive sublimate. Allow it to stand for 24 hours.

A green colouration will show the presence of bilirubin. Normal hydrobilirubin is red.

Clinical Significance.

A positive reaction denotes catarrh of the small intestine.

4. Fermentation Test.

Mix a piece of fæces of about the size of a walnut with water to the consistency of cream and with the mixture fill the lower chamber A. of a Strasburger's Fermentation Apparatus. Remove the tube with the closed end B. from its cork, fill with water, and replace in position, holding A. for the moment upside down whilst doing so. The apparatus is now in the following condition: A. filled with a mixture of fæces; B. filled with water; and C., at the extremity of which is a small perforation, empty. The apparatus must now be kept warm at a temperature of about 37°C for 24 hours. Any gas which is formed will drive the water out of tube B. into tube C., and will occupy its place. The test depends upon the fact that the degree of early fermentation with acidification of the mixture of fæces will be directly proportional to the amount of undigested carbohydrate, especially starch, which it contains. Putrefactive changes are usually later.

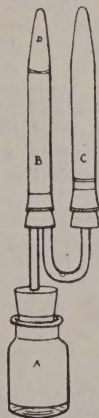


Fig. 8.

Clinical Indications.

- (a) Normally there should be very little gas formed in the closed tube.

- (b) If one-third or more of the tube is filled with gas, there is probably some pathological condition present. In this case test the fæcal mixture in the receptacle A. with blue and red litmus paper. If it is acid, there is fermentation of carbohydrates. If alkaline, there is albumin putrefaction. Early formation of gas usually denotes indigestion of starch in the intestine. Late formation of gas generally means putrefaction of proteids.

5. Incubation Test for the Presence of Anærobic Bacteria.

Whilst we can form some idea as to the relative number of Gram positive and Gram negative organism by counting a stained preparation, the fallacies and possible errors are many and the counting process occupies so much time that another method of more reliable nature is a desideratum. Fortunately the following easy process will answer our requirements as far as clinical work is concerned:—

We take several tubes of nutrient agar and melt them in a water bath. When they have cooled to 40°C. we introduce into the first tube with a pipette a little of the mixture of fæces from our Petri dish. From this tube we take a little with the pipette and transfer to a second, and so on, until we have all our tubes inoculated.

Instead, however, of pouring their contents into Petri dishes, we plunge them into cold water and thus cause the agar to solidify quickly. In each tube the cylinder of agar will be divided into three zones. An upper zone about 2 centimetres in depth which has absorbed air during cooling, a deep zone entirely deprived of oxygen, and an intermediate one. If we incubate these tubes we shall find that the strict aerobes will develop in the upper zone, the facultative anaerobes in the second, and the strict anaerobes in the lowest. A further distinction can be made between the facultative and strict anaerobes by the date of appearance of the colonies, the former appearing as a rule in 24 to 48 hours and the latter much later.

6. Test for Dissolved Albumin.

The most practicable method is that of Tsuchya (*described by Kolbe, "Examen Fonctionnel de l'Intestin," Archives des Maladies de l'Appareil Digestif, March and April, 1909, from which article the following directions are translated*). I have found the test easy to work and the results as claimed by the inventor.

A portion of well-mixed fæces about the size of a pigeon's egg for formed, and twice that quantity for liquid stools, is worked up with water until it is of the consistency of syrup. 10 c.c. of this mixture are placed in a porcelain

mortar and tested for acidity with litmus paper in order to see how much acidified alcohol must be added to precipitate the nucleo-albumins.

If the reaction of the stools is strongly acid, one must add .5 c.c.

If the reaction of the stools is slightly acid or neutral, one must add 1 c.c.

If the reaction of the stools is slightly alkaline, one must add 1.5 c.c.

If the reaction of the stools is strongly alkaline, one must add 2 or 2.5 c.c.

After the acid alcohol has been carefully mixed with the faeces in the mortar, 5 c.c. of chloroform are added, and the whole well mixed for the third time. The mixture is then placed in a test-tube and allowed to stand for some little time, when it will separate into two layers. The upper layer is decanted into another test-tube and a disc of copper sulphate agar allowed to fall into it. After an hour the disc is taken out, washed in water, and placed in a small white porcelain dish.

If the faeces contain a large amount of albumen, the disc will retain its original blue colour. If there are traces only, or complete absence, the disc will be brownish blue.

The next step is to pour upon the disc a little of the KOH solution used in the ordinary biuret test. If dissolved albumin be present, the disc will show the biuret reaction; *viz.*, it will become of a bluish violet colour.

Composition of the acid alcohol.

Glacial acetic acid, 10 grms.

Alcohol at 95, 90 grms.

Composition of the copper-sulphate agar-discs.

Boil 2 grms. of agar in 100 c.c. of distilled water until solution is complete. Add 10 c.c. of a 10% solution of copper sulphate in distilled water. The mixture is poured into a glass tube 1 c.c. in diameter which is provided with a plunger and a rubber cap.

For use, the rubber cap is removed, the plunger pushed into the tube until a piece of the contained agar jelly is expressed. This is cut off with a sharp knife level with the end of the tube and forms the disc used in the test. The rubber cap is then replaced to keep the contents from becoming dry.

Clinical Indications.

Dissolved albumin in the faeces denotes the presence of an inflammatory condition of the intestine, and will exclude functional diarrhoea and that arising from temporary irritation from dietetic errors.

TESTS WHICH INVOLVE DRYING THE STOOLS.

Whilst the preceding tests are sufficient in many cases to establish the diagnosis, there yet remain a few others which cannot be satisfactorily carried out without reducing

the fæces to a dry powder. These may be required in certain cases. They are: the estimation of the ratio of the weight of dry to moist fæces; the exact estimation of the fats; the recognition of stercobilin and the amount of inorganic ash.

7. The Drying of the Fæces

Is not difficult, and is carried out in the following manner:—

A porcelain capsule is placed in one of the scales of a balance and in the other a weight to which it is exactly equal. Each capsule in use should have its own balance weight which can be made out of a piece of lead. A weight of say 5 grms. is now added to the one in the scale pan, and fresh fæces placed in the capsule until the balance is perfect. We now have a known weight of fresh fæces. The capsule is now removed from the scale pan and heated on a water bath until its contents are quite dry. After it is apparently dry it should be weighed and again heated for half an hour, and again weighed. If the weight is the same, the drying has been thoroughly performed. If it has again lost weight, the drying should be continued until the weight is constant on two successive weighings. If any difficulty is found in the drying, the fæces should be well mixed up with a known weight of silver sand which has been washed in HCl. water and dried. We are now in a position to state

8. The Ratio of Dry to Moist Fæces.

Clinical Indications.

The normal ratio of dry to moist fæces should be about 68%, according to Rene Gaultier ("Coprologie Clinique," p. 327).

- (a) There is diminution in the amount of water when the biliary secretion is suppressed or diminished; or when both the biliary and pancreatic secretions are defective.
- (b) There is increase in the amount of water when there is defective absorption from the walls of the intestines.

We shall, of course, also meet with diminution of water, when the fæces remain for an abnormally long time in the intestine and *vice versa*.

9. Estimation of the Fat in the Stools.

For diagnostic purposes we require to know the percentage of total fat unabsorbed, of saponified fat, and of unsaponified fat, in the dry fæces. Whilst it is true that we can form a rough guess as to this from the microscopic examination of the cover glass preparations (see Micro-

scopic Examination, page 49), in serious and important cases such as those in which the question of definite disease of the pancreas arises, something more definite is required. The simplest method for estimating the fat and practically the only one within the capacity of the general practitioner is that advocated by Cammidge.

Place half a gramme of the dried powdered faeces into each of two Stoke's tubes (A. and B.) which have been provided with an extra 10 c.c. graduation mark on the lower bulb. Shake it well down into the bottom of the lower bulb. Into tube (A.) introduce a 1 in 3 solution of HCl. up to the 10 c.c. mark, and into tube (B.) the same amount of water; in doing so taking care to wash down into the bulb any of the faecal powder which may be adhering to the sides of the tubes. Heat tube (A.) in boiling water for 20 minutes, rotating it at intervals. Cool it in running water under the tap. Fill both tubes up to the 50 c.c. mark with ether, cork securely, and invert 40 times, occasionally rotating them in the hands. Allow them to stand upright for 1 hour. Take 20 c.c. of the clear layer of ether from each tube, and place respectively in a small flask of known weight. Evaporate on a water bath. Weigh the flasks again. The difference in weight of the first flask—that from tube (A.)—will give the amount of total fat. That of the second—from tube (B.)—the amount of neutral fats + fatty acids. The difference between the amount of total fat and the amounts of neutral fats + fatty acids, will be the saponified fat. The difference between the total fat and the saponified fat will, of course, be the amount of unsaponified fat.

Clinical Indications.

Normally the amount of unabsorbed fat should be from 15% to 25%; unsaponified fat, 10% to 15%; saponified fat, 10% to 15%.

Alteration in the Utilisation of Fat.

(a) Excess of saponified over unsaponified fat in the faeces may point to increased activity of the pancreatic secretion, and is frequently met with in hyperchlorhydria as the direct result of the excess of free HCl., the natural activator of the pancreas. Such an excess of pancreatic secretion is, I am sure, exceedingly common as the pancreatic catarrh which forms the first stage of chronic pancreatitis. Excess of saponified fat may also be due to the action of bacteria, and points to abnormal putrefactive processes in the upper part of the intestine. When this is the case there will be invariably other evidences of putrefactive processes in the intestine, such as indicanuria, and the usual syndrome of auto-intoxication. There will also naturally be evidence of defective pancreatic secretion, such as the presence of undigested muscular fibre and the

positive result of the tryptic insufficiency test, and we shall, under these circumstances, be justified in assuming that the excess of saponified fat means intestinal catarrh.

(b) Diminution of saponified fats. This will point to some degenerative change of the pancreas, is often met with in the later chronic stage of intestinal indigestion, and in conjunction with the pancreatic C reaction will suggest cirrhotic changes in the pancreas due to long-standing chronic inflammation.

(c) Excess of unabsorbed fat. This will show that there is some interference with the functions of the pancreas, provided that we can exclude defective gastric digestion, biliary obstruction, and an excess of fats in the food, especially those, such as mutton fat, having a high melting point.

Interference with the free passage of bile into the intestine, such as is met with in chronic disease of the bile ducts or in gall-stone disease, is characterised by:

(a) The same defective utilisation of fats as is met with in deficient secretion of the pancreas, but to a lesser degree.

(b) Deficiency in the colouring matter in the fæces.

(c) The presence in the urine of urobilin and bile pigment.

The presence of traces of bile in the urine is of greater diagnostic importance than is commonly supposed. Harry Adler has noted the fact that in many cases of obscure abdominal pain, in which gall-stones and chronic cholangitis were subsequently demonstrated by operation, he was struck by the fact that almost invariably traces of bile could be demonstrated in the urine by Rosin's test. (A green ring formed at the junction of the urine and a weak alcoholic solution of iodine. See page 15.)

10. Presence of Stercobilin.

Take some of the residue from the tube (B.) used in the estimation of fat; place it upon a filter, and wash with acidified alcohol. Neutralise the filtrate with ammonia, and mix with an equal quantity of a 10% solution of zinc acetate in absolute alcohol. Filter upon a fresh filter paper. If stercobilin be present, the filtrate will exhibit marked fluorescence.

Clinical Indications.

The presence of stercobilin excludes occlusion of the bile duct.

11. Amount of Inorganic Ash.

Weigh a small portion of the dry powdered fæces upon a platinum capsule of known weight. Heat to redness. Weigh again. The loss in weight will be the amount of

the organic matter. The present weight deducting in each case the known weight of the capsule will represent the amount of inorganic ash.

Clinical Indications.

The normal amount of inorganic ash varies from 10% to 15% of the dry weight of the dry faeces. Increase of the amount of inorganic ash is met with in catarrh of the large intestine, and strongly suggests chronic colitis.

Examination of Blood.

I.—THE DIAGNOSIS OF SYPHILIS.

By the simplified Wasserman's Test.

A positive reaction obtained with this serum test demonstrates with certainty that the syphilitic virus is still present, even if the patient has been treated many years previously for the disease. The original Wassermann's test required an intimate knowledge of serology, and many attempts have been made to simplify that test in such a manner as to bring it within the reach of the general practitioner. The technique here described represents the latest modification, requiring very little time and skill, and giving invaluable information for diagnosis and prognosis. For the latter it is especially useful in the later stages, for it is of great importance to continue treatment until the positive reaction is replaced by a negative reaction. In differential diagnosis it is of importance in syphilis versus tuberculosis, carcinoma, and psoriasis.

In order to explain the rationale of the test it must be stated that if an animal be naturally infected with bacteria, or experimentally with bacteria or other *antigen*, such as cells, blood corpuscles, etc., its serum will be found to possess the property of acting upon and dissolving such antigens in the test-tube. This property of the serum depends upon the presence of two bodies: (1) COMPLEMENT, a substance which is normally present in the serum, and which is destroyed by heating the serum to 56°C., and (2) IMMUNE BODY, a substance specially developed as the result of the infection, and which, in contradistinction to

the complement, is thermo-stable. If the serum containing these two substances is heated to $56^{\circ}\text{C}.$, it becomes inactive, and no longer exercises the lytic action referred to: but this power can be restored to the serum by adding to it a small quantity of normal serum. The Wassermann reaction depends upon the inter-action of two distinct antigens, and two immune bodies, one specialised for each antigen, and indifferent complement. The one immune body is the substance found in the serum of syphilitic patients, which enables the indifferent complement to combine with the syphilitic antigen (alcoholic extract of syphilitic liver). The other immune body (hæmolysin) is a substance present in the serum of a rabbit experimentally injected with blood corpuscles, and which serum has been inactivated by heating to $56^{\circ}\text{C}.$ Such rabbit serum, when added to an emulsion of blood corpuscles, in the presence of the indifferent complement, results in the destruction of the corpuscles and the diffusion of the hæmoglobin through the fluid in which they are suspended.

If now serum from a patient containing syphilitic immune body is mixed with syphilitic antigen and complement, these three bodies will form a mixture in which the complement is no longer free. If added to an emulsion of blood corpuscles already "sensitised" as it is termed, by the addition of inactive hæmolytic serum, the absence of free complement prevents the destruction of the red cells taking place. If, however, the serum from the patient contain no syphilitic immune body to bind the complement to the syphilitic antigen, the complement remains free and is ready to enter into combination with the hæmolysin and red cells, and hæmolysis results.

DIRECTIONS FOR USE OF THE APPARATUS.

For the performance of the modified Wassermann reaction the following are necessary:—

1. Physiological salt solution. Prepared by dissolving one of the salt tablets in 12 c.c. of water.
2. Antigen. (Alcoholic organic extract.)
3. Complement. (Guinea-pig serum dried upon filter paper.)
4. Amboceptor. (Hæmolytic immune serum prepared against human red corpuscles.)
5. Patient's serum, and emulsion of human red cells. Obtained by collecting 20 to 25 drops of blood from the patient, transferring it to the defibrinator, and shaking until filaments of fibrin are seen attached to the beads. Use fresh beads for each test.

The reaction is performed as follows:—

Open the bottle containing antigen and draw the fluid up into dark amber glass pipette to the graduation.

Eject this into tube No. 1.

Add 2 c.c. salt solution to the antigen in tube No. 1.

Place 2 c.c. salt solution in the tube No. 2. (This tube forms the control.)

Place two complement papers in each test-tube. These must be completely immersed in fluid.

Take up defibrinated blood in the blue pipette to the graduation mark. Transfer this to tube No. 1.

Put an equivalent amount of defibrinated blood in tube No. 2.

Let the two tubes remain at the temperature of the room for an hour. Shake from time to time.

By means of the ungraduated pipette transfer the contents of one amboceptor bulb to tube No. 1, and a similar quantity amboceptor to tube No. 2.

Shake well.

Ten to fifteen minutes later again shake.

In a short time the control tube (No. 2) will show solution of the blood corpuscles, and the liquid will become red.

In tube 1, if the reaction is negative, the appearances will be identical with those in the control tube (either at the same time or a little later). If the reaction is positive, tube No. 1 will show a sedimentation of the red corpuscles, but no solution, and in about 30 minutes the blood corpuscles will have settled to the bottom of the tube without the blood cells being dissolved, and the supernatant liquid will be clear and light. A certain amount of solution of the red corpuscles may take place if it is allowed to stand for some hours.

As a preliminary it is recommended that serum known to yield a positive result should be tested, and also serum from a healthy individual.

II.—TYPHOID AND MALTA FEVER.

(Agglutination Tests).

The first step is to obtain the patient's serum. The apparatus required are: Wax vesta, blood pipette, and needle. Thoroughly cleanse the lobe of the ear, or a finger near the nail, with soap and water, afterwards rubbing vigorously with a pad of absorbent wool moistened with ether. Prick the prepared spot deeply with the needle in such a manner that a large drop of blood exudes. Break off both sealed ends of the blood pipette, and hold its bent end to the drop of blood, which will then enter the pipette by capillarity. Sufficient blood should be collected (squeezing the part if necessary) to fill at least half the body of the pipette. Now seal off the straight end of the latter by holding it in the flame of the wax vesta.

The heat thus communicated to this end of the pipette will in a short time cause the whole of the blood to travel towards it leaving the bent end free, which may then be sealed in its turn. Shake down the blood into the straight end. The pipette is now hermetically sealed, and may be carried away. In order to obtain serum from the contained blood, the pipette should be allowed to stand for about four hours in a cool place, by which time the clot will have separated, and will be found to be floating in clear serum. Should the necessary apparatus be at hand, the same result may be obtained in a few minutes by centrifugalisation.

Method of Performing the Test.

Take two of the sealed tubes of bacillary emulsion. Of one, carefully shake down the contents, and break off the thin stem after making a file-mark. Next notch with a file the body of the blood pipette containing the patient's blood, above the level of the contents, and break off carefully. Take the pipette provided with the rubber tube and suck up enough of the clear serum surrounding the clot to reach the graduation-mark on the stem. Transfer this to the emulsion tube by introducing the capillary portion of the pipette through the broken-off end, and blowing the contents into the emulsion. The serum thus introduced must be clear and free from corpuscles. Again seal up the emulsion tube in the flame, taking care not to heat the contents. When cold, shake vigorously in order to mix thoroughly the emulsion and the serum. Label this tube carefully, and place it side by side with the intact one (which is to act as a control) in a vertical position in a good light, where it may be observed from time to time.

Reaction.

In cases which are going to prove positive, the reaction may appear as early as one hour, or may be delayed for four or five. The first sign of reaction is that the contents of the test-tube become granular, succeeded by the appearance of light flocculent specks, which gradually sink to the bottom of the tube. The control tube remains clear, or at most shows a light, powdery deposit. It should, of course, receive a good shaking prior to being placed alongside the test-tube. If there is no apparent difference between the two tubes after six hours the reaction may be considered negative.

The graduated serum pipette must be carefully cleansed after the performance of each test. To do this, water, spirit, and ether are sucked up successively; the pipette being completely filled about ten times with each. After the ether, air should be blown through until the pipette is dry. A fresh plug of wool is then introduced into the large end, and the pipette put carefully away

Points to Remember.

Do not overheat blood pipette or emulsion tube when sealing. Wipe the end of the serum pipette dry before introducing its point into the emulsion tube, and see that contents of latter are well shaken down from the neck. Examine the test and control tubes carefully and frequently.

III.—TUBERCLE INFECTION.

Tuberculin Tests.

1. Pirquet's Cutaneous Reaction.

This is indicated to establish an antecedent infection with tubercle bacilli, in individuals of any age. It may be used in cases with fever, in contrast to the tuberculin injections of Koch. It is strongly recommended for employment with children. Active and quiescent cases of tubercle give a positive reaction.

In order to carry out the test several scarifications are made, one or two of which must be regarded as controls, and into these no tuberculin is inserted. The positive reaction consists of a more or less extensive inflammatory reddening of the skin, in the neighbourhood of the inoculation, which persists for several days.

Method of Performing the Test.

The inner aspect of the forearm is washed with ether, and 2 drops of old tuberculin is sprinkled from the capillary tube at a distance of about 10 c.m. from each other. Then a piercing scarification is made with a vaccination lancet, first midway between the two drops and then on the inner side of each. A few fibres of cotton wool are placed on the drops in order that the tuberculin should not flow away from the site of inoculation. The cotton wool may be removed after ten minutes. A bandage is unnecessary, for it only disturbs the course of the reaction.

Reaction.

It is necessary to distinguish between the traumatic or negative reaction, and the positive reaction.

The *traumatic effect* consists of a faint redness, which vanishes in about 24 hours, almost completely, leaving only a scab the size of a pin's head. The negative reaction is similar in character.

The *positive reaction* ensues after a latent period of several hours, and it consists of an inflamed, slightly raised redness, which rapidly extends and comes to its height. A papule of 10 mm. and more in diameter is formed, and its colour varies from an intense to a pale red. If there is advanced anæmia, this hyperæmia may fail to appear (cachectic reaction). The maximum dimensions of the papule, both in superficial area and in height, are usually

attained in 48 hours after inoculation. The reaction passes off in 5-8 days, but some pigmentation at the site of inoculation remains for some time. In certain tubercular individuals, namely in children, signs of severe infiltration appear, owing to their excessive susceptibility; but, even in these cases, a complete cessation of the process occurs in a few days, at most in a week, and no permanent harm results.

2. Calmette's "Ophthalmic" Reaction.

For this purpose a special Tuberculin is supplied in sterilized glass tubes. Proceed as follows:—

1. Remove the indiarubber cap, to uncover the sharp point of the tube, which must be broken.
2. Replace the cap, and hold the tube horizontally.
3. Break the blunter end of the dropper at the file mark.
4. Separate the lids of the eye to be tested, and let one or two drops of the fluid in the pipette fall on the ocular conjunctiva (near the caruncle). Keep the eyelids apart for a moment.
5. A positive reaction is at its maximum between 18 and 36 hours from the time of instillation, when the tested eye, as contrasted with the other, shows swelling and injection of the caruncle, injection of the ocular conjunctiva, epiphora, and sometimes muco-pus.
6. The reaction usually passes off in two to four days.

IV.—THE ESTIMATION OF HÆMOGLOBIN- CONTENT OF BLOOD.

The principle of the method is as follows:—A measured quantity of the blood to be examined is mixed with ten times its amount of dilute hydrochloric acid of known concentration. This mixture becomes of a brown colour, owing to the development of a compound of hydrochloric acid and hæmatin. The mixture is further diluted with water in a graduated tube, until its colour corresponds in transmitted light with a standard solution supplied with the instrument. This standard solution contains the same blood derivative in definite dilution. The content of pigment in the blood is ascertained by the amount of dilution required in order to make the colours correspond. This method is superior to previously employed faulty clinical estimations of hæmoglobin, and also supersedes Gowers' and Fleischel-Miescher's methods, because the correspondence in colour depends upon substances which are perfectly uniform in chemical constitution and in colour, so

that a careful appreciation of colour, by the eye, leads to a much more accurate result.

The Method of Estimating Hæmoglobin.

The small graduated glass is filled up to the mark 10, either by means of the larger pipette or a drop bottle, with the dilute hydrochloric acid (1.5 HCl. in 100 c.cm water), which serves as the reagent. Then the patient's finger-tip is sharply punctured with a lancet, so that a medium-size drop of blood wells up, without any considerable pressure. The skin of the finger must previously be well dried, so that the drop of blood does not tend to spread superficially; 20 c.m. of blood are sucked up, by means of the capillary pipette, and blown into the graduated glass containing the dilute hydrochloric acid. By repeatedly sucking up the contents of the glass into the pipette, and repeatedly blowing them out again, it follows that none of the blood will be left in the pipette, which is an important matter, as the standard solution is estimated on this consideration. This manœuvre of sucking up and blowing out the blood is also the best means of ensuring its thorough admixture with the hydrochloric acid. After waiting one minute the mixture becomes dark brown in colour, and therewith also almost completely clear. Then water is gradually added to the mixture by means of the larger pipette or a drop bottle, the whole is shaken up, placed in the ebonite stand opposite the standard solution, and the process continued until, in transmitted light, the mixture assumes precisely the same colour as the standard solution. The figure marked on the graduated glass at the point to which it is filled with water, in order to obtain the required tint, represents the percentage of blood in hæmoglobin. It is desirable in order to compare the tints, to turn the graduated glass in such a manner that the scale is hidden behind the rim of the ebonite stand. This has the advantage of preventing the scale from interfering with the clearness of the colour perception, and the observer is less liable to be prejudiced in regard to the anticipated hæmoglobin content, by any preconceived ideas. In order to still further avoid any error from this source, the whole of the upper portion of the glass can be concealed during the estimation by placing some opaque paper in front of it, so that the height of the fluid in the graduated glass cannot be seen.

As previously stated, the examination can be conducted by any light, and, in contrast to other methods, it yields the same results in artificial light as in daylight. In order to obtain the most precise estimation, the examination can advantageously be undertaken in a dark room, with artificial illumination supplied by a condensed light, like a laryngeal lamp or lantern, under which conditions the colour and light perception of the eye is most sensitive. Such refinement is, however, unnecessary in ordinary cases.

On the Selection of Apparatus and Reagents.

The first difficulty which will confront the medical man who decides to make use of laboratory methods in his daily practice will be the selection of the necessary material. This alone will often deter a busy man from commencing such work. For his convenience a list will now be given of the apparatus and reagents which are required for the different tests enumerated in this volume arranged for convenience in groups for the respective examination of the urine gastric contents, stools, etc.

At the suggestion of the authors, the Roborat Company, 8, Harp Lane, London, E.C., have rearranged their well-known test cases to contain the apparatus necessary to perform the tests given in this book.

I.—EXAMINATION OF THE URINE.

Qualitative (routine) Examination.

Apparatus required.

12 Test tubes	1 Thermometer
2 Boiling tube	1 Pipette 5 ccm. } 1/20
2 Funnels	1 Pipette 1 ccm. }
2 Beakers	1 Graduated measure
100 Litmus test, red	1 Grad. tube 20 ccm.
100 „ „ blue	2 oz. grad. cylinder
Filter papers	Watch glasses
1 Spirit lamp	Droppers
Glass rod, tube brush	Tripod
1 Gravidimeter	Asbestos plate
1 Ureameter	Etc., etc.
1 Esbachmeter	

Reagents required.

Phosphotungstic acid	Sod. nitrite
Copper sulphate	Hydrochl. acid conc.
Citric acid	Pot. permangan.
Haine's (sugar) test	Chloroform
Nylander's (sugar) test	Sod. nitroprussid.
Picric acid solution	Ammon. caust. conc.
Spiegler's (albumin) test	Ferr. perchlor. sol. 10%
Silver nitr. 12% sol.	Sulphuric acid conc.
Nitric acid conc.	Pot. hydroxid.
Hydrogen perox.	Bromine 1 ccm.
Aloin	Salicyl. aldehyde.
Acetic acid conc.	Benzidine, etc.
Sulphanilic acid	

A complete outfit, containing all the above specified apparatus and reagents in mahogany case and stand is supplied under the name of "Qualitest" through the dealers.

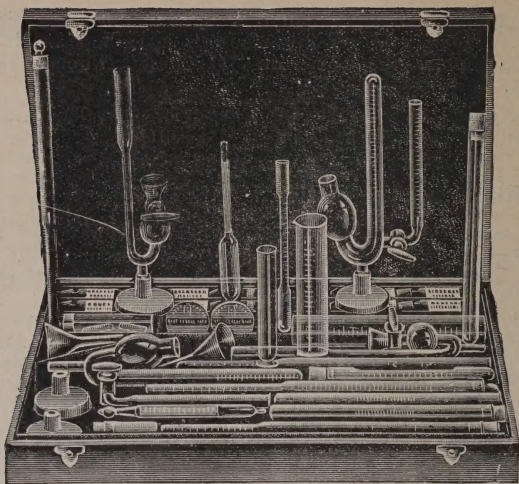
A very small outfit for the pocket, to test for sugar, albumin and reaction, is supplied in book form ("Pocket Qualitest").

Quantitative Examinations.

A complete outfit of instruments and reagents as described in this volume for the qualitative and quantitative analysis of urine, stomach contents, fæces, blood, can be obtained under the name of "Quantitest." It contains the Saccharometer, Albuminometers, Ureameter, Uricometer, Acidimeter, Phosphatometer, Sulfatometer, Ammoniameter, Indicanometer, Spec. Gravidimeter, the tubes for the gastric analysis, Strauss' Cylinder, all necessary test solutions, litmus and Congo papers, beakers, funnels, etc., etc.



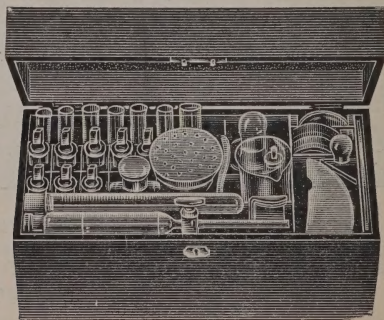
A smaller outfit for the urine work only is also supplied. It contains all the principal instruments, but small quantities of the more important test solutions only.



II.—ANALYSIS OF STOMACH CONTENTS.

Apparatus required.—1 “Quantitest” Acidimeter, 1 Strauss separating cylinder, litmus (red and blue), Congo papers, beaker, funnel, porcelain filter, 20 c.cm. grad. tube, watch glasses 6 test-tubes, tripod stand and spirit lamp, evaporating basin, collecting flask, graduated tubes, pestle, filter papers, bottle to hold stomach content.

Reagents required.—Deci-normal solution of sodium hydrate, hydrochloric acid (for Hammerschlag’s test), picric acid, copper sulphate, caustic potash solution, calcium chloride, Lugol’s solution, ferric chloride solution (10%), ether, acidometer (indicator) reagent, hæmatoxylin, sodium nitrate, sulphanilic acid, powdered chlorate of potash, potassium ferrocyanide, glacial acetic acid, tablets for making Günzberg’s test, alcohol (90%), benzdine, aloin, egg albumin, methyl orange.



A complete outfit is supplied under the name "Gastrotest," containing all the specified apparatus and reagents in a neatly arranged mahogany case.

III.—ANALYSIS OF FÆCES (AND FOR PANCREATIC REACTION).

Apparatus required.—Test-tubes, Strasburger's fermentation apparatus, 2 Stokes' tubes with 10 c.c. mark, tube containing copper sulphate agar, 2 flasks with 40 c.c. mark (flat bottoms to stand), condenser stopper, measure glass with 2 c.c. graduation mark, measuring cylinder for Camidge's reaction, filter and filter papers, Petri dish, microscopic slips and cover glasses, pestle and mortar, glass spoon, glass rods, pipette, cotton wool for stoppers for test-tubes, lamp tripod and asbestos wire mat, beakers, preferably nested.

Reagents required.—Glacial acetic acid, peroxide of hydrogen, corrosive sublimate saturated solution, nutrient agar in tablets for making agar tubes for the incubation test, ether, ammonia, 10% zinc acetate in absolute alcohol, acid alcohol for Tsuchya's dissolved albumin test, blue and red litmus paper bibulous, acetic acid 50%, pure HCl, concentrated soda solution for making the 1 in 1000 required for the casein pancreatic insufficiency test, tablets for making Gram stain and neutral red counter stain, methyl alcohol for dissolving the tablets.

Powders.—Carbonate of lead, 8 grms.; tribasic acetate of lead, 8 grms.; sulphate of soda, 4 grms.; sodium acetate, 2 grms.; phenyl hydrazin hydrochlorate, .8 grms.; casein, .05 grms. for trypsin test.

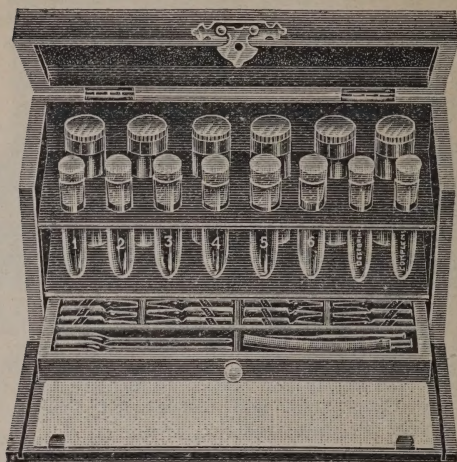
A complete set of the apparatus and reagents is supplied under the name of "Pancreatest," complete in mahogany case.

IV.—ANALYSIS OF BLOOD.

1. Wassermann's Test for Syphilis.

This test might now be rapidly performed by means of a special outfit designed for the purpose. It contains sufficient material for 6 tests. The Antigen (6) and Amboceptor (12) are supplied in sterile glass ampullæ, the Complement dried on filter paper. The case contains also 50 salt tablets and graduated tubes for preparing the physiological salt solution. In a specially-designed tube the patient's blood can be defibrinated by means of small glass beads, and carefully graduated green and brown glass pipettes are supplied to obtain the necessary quantity of blood and Amboceptor.

12 special tubes numbered and marked are arranged in two rows, the back row holding the 6 tubes for the control tests, the front row the 6 tubes for the proper tests. A small knife is also provided for cutting the ampullæ. The whole process is rendered easy, and perfectly suitable to be carried out in the consulting room.



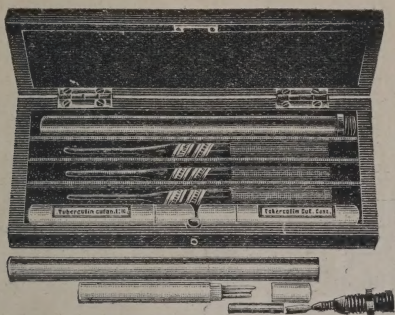
2. The Agglutination Tests for Typhoid and Malta Fever.

The "Typhognost" and "Maltagnost" described in this volume are small outfits containing the emulsion tubes, blood pipettes, blood capsules, and a small knife to cut the ampullæ. "Sedimentation" tests can be carried out without any bacteriological outfit or microscope, and are perfectly safe and rapid.



3. Test for Tubercle Infections.

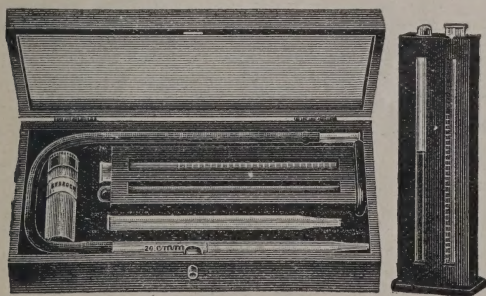
For performing this test two special tuberculin preparations are supplied, one for the cutaneous (v. Pirquet's), and one for the ocular reaction (Calmette's). The best inoculating lancet is the original v. Pirquet's, with a platinum-iridium point, which enables one to scratch the skin just sufficiently for the purpose. A convenient outfit can be



obtained which contains v. Pirquet's Lancet, also 5 doses of each, concentrated and diluted (1:10) Tuberculin, and 3 doses for the Ocular test; also a knife for cutting the ampullæ, with a small tube of absolute alcohol for disinfecting the skin.

4. Estimation of Hæmoglobin Content in Blood.

The most recent and best method is the one invented by Prof. Sahli, and has great advantages over the older



(Gower's, etc.) methods. The normal solution provided is a standardized blood solution, which will keep indefinitely,

and which will enable a most precise and rapid estimation to be made in daylight or any artificial light within a few minutes.

V.—BACTERIOLOGICAL EXAMINATIONS.

For the bacteriological routine work the "Bacteriotest" will be found a complete and practical outfit, suitable either for the commencing bacteriologist or the expert. It has been designed *ex praxi per praxi*, and contains all necessary appliances ready for the performance of practically any test that might come within the fields of a medical practitioner. The front lid is covered with a glass plate, and will serve as a working table.



THE OUTFIT INCLUDES:

Gramm's Stain	Petri Dishes
Jenner's Stain	2 Funnels
Carbol Thionine	Watch Glasses
Blue	2 Pairs Forceps
Borax Methyl	Spirit Lamp
Blue	Filter Papers
Nitric Acid 25	3 Tubes Broth
per cent.	3 " Agar-agar
Carbol Gent.	3 " Gelatine
Viol.	3 " Blood
Carbol Fuchsin	Serum
Xylol	Washing Flask
Spirit	with 2 Tubes
Leishman's	and Rubber
Stain	Stoppers
Pipettes	Also complete
Glass Rod	sets of appar-
Immersion Oil	atus for Wi-
Canada Balsam	dal's reaction,
Slides	'Typhognost'
Cover Glasses	and for simpli-
Platinum	fied Opsonin
Needle	Estimations
Grad. Measures	(Wright's Me-
Pipettes for	thod), 'Opso-
Stains	notest,' etc.,
Copper Tripod	
Stand	

The above described instruments can be obtained through the ordinary trade channels.



